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REVIEW ARTICLE



# Analysis of clinical characteristics and management of ectopic third molars in the mandibular jaw: a systematic review of clinical cases

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**ABSTRACT**

**Objective:** To perform a systematic review of the characteristics of ectopic mandibular third molar (EMTM) in terms of its clinical presentation, radiographic findings, associated lesions, management and post-operative complications.

**Materials and methods:** We searched the Pubmed, Medline, Embase and EBSCO databases for full-text, peer-reviewed journal publications from January 1965 to August 2020. Data extraction was done using preferred reporting items for systematic reviews and meta-analyses (PRISMA) guidelines.

**Results:** Our search yielded 45 case reports involving 48 EMTM teeth. The mean age of the patients was 46.3 years with an age range of 22–80 years. Thirty-two cases were seen in women as compared to 13 cases in men. The majority of the cases (42) were unilateral, with only three bilateral cases. Among the 48 EMTM teeth, 21 were seen in the condylar region followed by 13 in the ramus, seven in the sigmoid notch, three in the angle and two each in the coronoid process and the lower border of the mandible. Twenty-five EMTM teeth had histopathologically confirmed dentigerous cysts, eight teeth had chronic infection/inflammation/granulation tissue, two had radicular cysts, two had infected cysts, two teeth had normal follicular spaces, and associated lesions were not mentioned for nine teeth. The most common symptoms were swelling (33 teeth) and pain (29 teeth), and six teeth were asymptomatic. Surgical removal through intraoral approach was carried out for 27 teeth, while an extra-oral approach was adopted in 15 teeth, a spontaneous regression of the pericoronal radiolucency was noticed in one tooth, four teeth were not treated and choice of treatment was not mentioned for one tooth. Mild transient paraesthesia was frequently observed; however, serious post-surgical complications were not reported.

**Conclusions:** The present review found that EMTM can present with complex clinicopathological characteristics, with a majority of the cases being asymptomatic in the beginning and turning out to be symptomatic with lesions at later stages, requiring surgical intervention.

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Abnormal; ectopic teeth; heterotopic; mandibular; position; ramus; third molar

## Introduction

The term 'Ectopic tooth' is a clinical condition characterized by the presence of a tooth in a non-dentate area, distant from its usual anatomical location [1]. Ectopic mandibular third molar (EMTM) is a relatively rare clinical entity characterized by its unusual location and found in different anatomical regions of the mandible [1,2]. The majority of these cases are unilateral, nonetheless; few bilateral ectopic teeth have been reported [3]. Although the mandibular third molar (MTM) is the most frequently impacted tooth with a frequency of 20–30%, the true incidence and aetiology of EMTM remain unclear due to its complexity [4]. Inadequate space on the posterior side of the mandible is the common reason for the impaction of MTM. Abnormal position of the MTM bud, an aberrant eruption pattern [5], abnormal strong eruption forces and the discrepancy between the base and the direction of growth of the MTM have been suggested to be the other reasons for EMTM [1,6,7]. Although many hypotheses have been put forward to explain the aetiology, it remains unclarified and cannot be determined in all the cases [1].

The majority of EMTM are diagnosed because of their clinical signs and symptoms, and only a few are incidentally discovered during routine radiographic examination. The clinical signs and symptoms include pain, swelling, facial asymmetry, trismus, acute infections and sinus formation [8–10]. Only a handful of cases remain asymptomatic throughout life [1]. Though panoramic radiographs (OPG) are sufficient in diagnosing EMTM, computed tomography (CT) and cone beam computed tomography (CBCT) could play a role in further diagnosis and treatment planning [1,10]. Owing to the complex nature of EMTM and lack of comprehensive review on this condition, we aimed to systematically review the related literature over the past 55 years (1965–2020) to characterize their clinical presentation, radiographic findings, associated lesions, management and post-operative complications.

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## Systematic review

We aimed to identify all full-text, peer-reviewed publications pertaining to EMTM. For comprehensive and transparent reporting of this review, we adopted the preferred reporting items for systematic reviews and meta-analyses (PRISMA) reporting guidelines and the present review was registered in PROSPERO with the registration number CRD42020218528.

We searched Pubmed, Medline, Embase and EBSCO databases for English-language literature on EMTM published from January 1965 to August 2020. The following search terms were used: ectopic tooth, third molar, ramus, condyle, coronoid, sigmoid notch, angle of the mandible, and aberrant. The reference lists of chosen articles were searched to identify relevant articles. The identified articles were assessed for inclusion independently by two authors. Our review was confined to human studies published in English language. Human cadaver head studies, iatrogenic displacement and papers with incomplete information such as missing demographic details and location were excluded. Further, the methodological quality of each case report that met the inclusion criteria was critically appraised using JBI Critical Appraisal Checklist for Case Reports [11].

The information that was extracted were as follows: author; year of publication; demographic information of patients that included age and gender, location, position, clinical findings, radiographic findings, associated lesions, management and postoperative complications. Owing to the qualitative nature of this review, and the studies selected being only case reports, no meta-analysis was performed, or effect size was calculated.

## Results

We examined 43 published articles and identified 38 articles relevant to our review topic that met our criteria. All the 38 articles were included for final review as they met the inclusion criteria as per the JBI Critical Appraisal Checklist for Case Reports. The search strategy and flow diagram (Figure 1) are presented using the PRISMA guidelines. Results were focused on the clinical features, radiographic features, associated lesion, management and post-surgical complications. The results of these 38 studies are summarized in Table 1 [12–44]. The 38 studies selected were case reports and case series published between January 1965 and August 2020. Among the 38 included articles, there were 45 case reports with 48 individual EMTM teeth.

### *Demographics (age and gender)*

All 45 case reports mentioned patients' age which varied across studies from 22 to 80 years with a mean age of 46.3 years. Gender was also reported in all the included studies. Among the 45 cases, 32 were females (71%) and 13 (29%) were males (Table 1).

### *Clinical features*

#### *Symptoms*

Forty-two of 48 EMTM teeth (87%) were symptomatic as compared to only six asymptomatic teeth (13%). The most common symptom was swelling which was seen in 33 teeth (78%), followed by pain seen in 29 out of 42 teeth (69%). Trismus was seen in 14 cases (33%), purulent discharge in nine cases (21%), sinus opening in four cases (10%) and a bad taste in two cases (5%). Rare symptoms included facial asymmetry [16], TMJ dysfunction [43], dysphagia [42] and deviation of the mandible [24] with one case each (Table 1).

### *Radiographic features*

#### *Location*

Of the 45 reported cases, 42 cases (93%) were unilateral and only three (7%) cases had bilateral EMTM of which two were found in the ramus and one in the condyle. Of the 42 unilateral cases, 21 (50%) were seen on the right side and 21 (50%) were seen on the left side of the mandible, in the ratio of 1:1 (Table 1).

#### *Radiographic position*

The most common position among the 48 individual EMTM teeth was the sub-condylar/condylar region (21), followed by the ramus (13), sigmoid notch (7), angle of the mandible (3) and the least common sites were the coronoid process and lower border of the mandible with two teeth each.

Twenty-six out of 48 EMTM teeth (54%) were inverted, wherein the roots of the impacted teeth were directed towards the condyles, 14 teeth (29%) were vertically impacted wherein crowns were positioned towards condyles and eight teeth (17%) were horizontally positioned.

Out of 48 individual EMTM teeth, 41 (85%) were associated with small to large pericoronal unilocular radiolucency, four teeth displayed normal follicular space, one had bony sclerosis and in two teeth, the findings were not specified (Table 1).

### *Associated lesions*

Of the 48 EMTM teeth, 25 (52%) had histopathologically confirmed dentigerous cyst, eight (17%) had chronic infection/inflammation/granulation tissue, two teeth had a radicular cyst, two had infected cysts, two teeth had normal follicular space and the associated lesion was not mentioned for nine teeth (Table 1).

### *Management*

Of the 48 EMTM teeth, 27 (56%) were treated by an intraoral approach, 15 teeth (31%) were treated by an extraoral approach, four teeth did not undergo any treatment as they were asymptomatic, spontaneous regression of radiolucent lesion was noticed in one tooth and treatment was not mentioned for one tooth (Table 1).

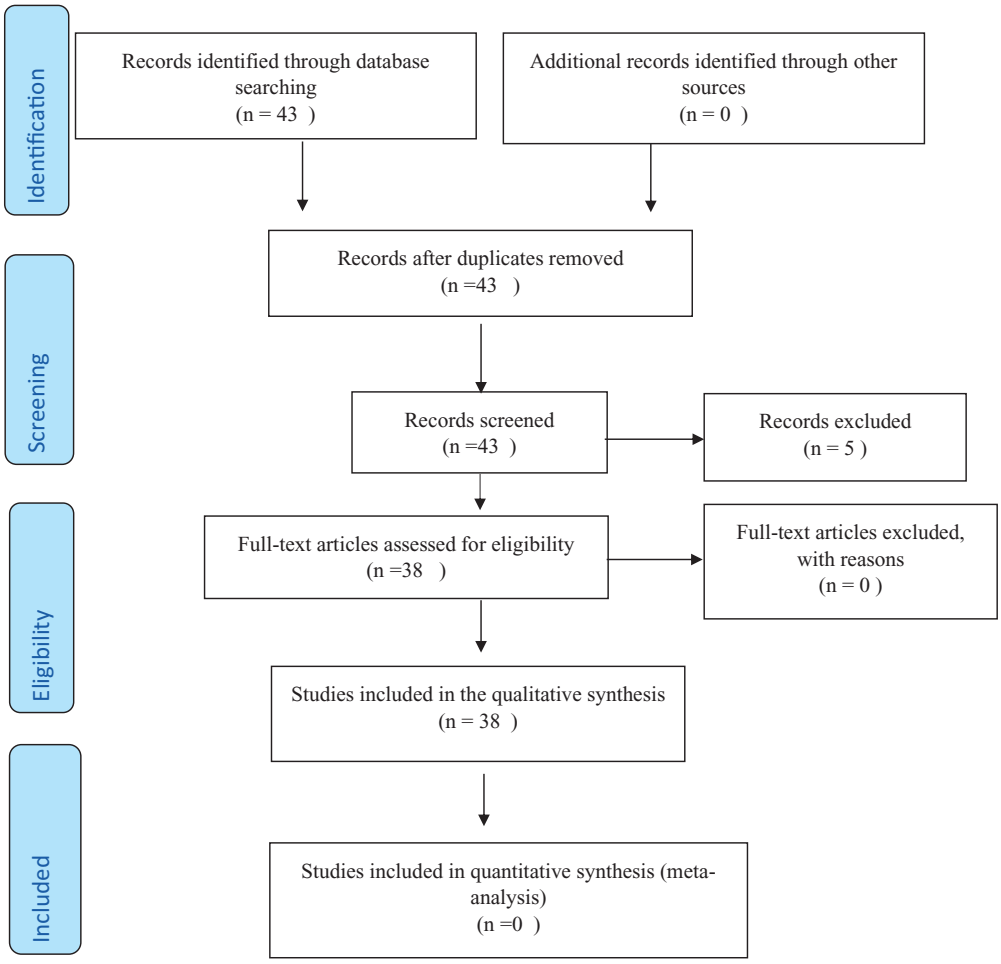


**Figure 1.** PRISMA flowchart of the literature search.

### *Postoperative complications*

Fourteen (29%) EMTM teeth reported minor complications such as transient paresthaesia. In 16 teeth (33%), postoperative complications were not mentioned and 12 teeth (25%) had an uneventful recovery, and surgery was not performed in six teeth (13%) (Table 1).

## Discussion

EMTM is a rare clinical entity, usually found at heterotopic places distant from their physiological sites such as the angle of mandible, the ramus, condyle, coronoid process, sigmoid notch, or even in the adjacent soft tissue spaces [45]. The fact that we could find only 45 case reports in the past 55 years itself talks for its rarity. However, the true prevalence of EMTM appears to be biased due to a higher tendency of reporting symptomatic cases and underreporting of asymptomatic cases, particularly those located in the lower border, angle and ramus of the mandible [36].

Our review found that more than 70% of the patients with EMTM were above 40 years of age. It is not clear whether EMTM occurs at such a later age or symptoms become prominent to establish a diagnosis at that age. Also, the prevalence was found to be higher in women as compared to men with a ratio of 2.5:1. Though the exact reason for this difference is unknown, it could be attributed to the differences in the growth pattern of the mandible in males and females.

We found that about 50% of EMTM teeth were found in the subcondylar and condylar regions. This could be due to the growth patterns of the mandible. During mandibular development, the ramus elongates and grows upwards carrying the tooth bud along with it to the condylar and coronoid process [7]. Furthermore, the condylar process develops because of bone tissue apposition in the posterior aspect of the ramus and resorption on the anterior border thus facilitating the tooth bud into the condylar or coronoid process [8]. Also, the pressure exerted by the large cyst around the EMTM may displace the tooth into the condyle or sub condylar region [7].

Additionally, the majority of EMTM may remain asymptomatic for a long duration until they migrate to the condylar region and displays clinical and radiographic signs. There could be a possibility of under-reporting of cases in the other regions of the mandible as EMTM in the condylar position is more likely to be published because of their rarity and uniqueness. Owing to the lack of a unified classification for EMTM, Wu et al. proposed a refined classification based on the anatomic site on radiographs. They were grouped

**Table 1.** A systematic literature review of EMTM.

| Author | Age/ gender | Unilateral/ bilateral | Side right (R), left (L) | Location | Position | Clinical findings | Radiographic findings and diagnostic radiograph taken | Management | Complications | Associated lesion |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. Traiger et al. [12] | 47/F | Unilateral | L | Sigmoid notch | Inverted | Swelling, trismus | Pericoronal radiolucency. Posteroanterior view | Extraoral access | Uneventful | Infected cyst |
| 2. Markowitz et al. [13] | 23/F | Bilateral | R and L | Mid ramus | Vertical | Atypical facial pain | Pericoronal radiolucency. OPG | Intraoral access | Transient paraesthesia | No lesion |
| 3. Burton and Scheffer [14] | 57/F | Bilateral | R and L | Subcondylar | Inverted | Pain, swelling, draining sinus tract | Not specified. OPG | Intraoral and extraoral access | Not mentioned | Bilateral dentigerous cyst |
| 4. Chongruk et al. [15] | 27/F | Unilateral | L | Sigmoid notch | Vertical | Asymptomatic | Normal follicular space. OPG | No treatment has done | | |
| 5. Toranzo Fernandez and Terrones Meraz [16] | 80/F | Unilateral | L | Coronoid process | Horizontal | Facial asymmetry, swelling, pain, trismus of 7 years duration | Unilocular radiolucency extending to coronoid process and sigmoid notch. OPG | Not mentioned | Uneventful | Infected cyst |
| 6. Bux and Lisco [17] | 66/F | Unilateral | R | Subcondylar | Horizontal | Pain, swelling, spontaneous drainage, reactive lymph nodes, | Pericoronal radiolucency. OPG | General anaesthesia extraoral access, incision below the right mandibular angle | Uneventful | Dentigerous cyst |
| 7. Adams and Walton [18] | 45/F | Unilateral | R | Angle | Horizontal | Unpleasant tasting discharge | Well-defined, unilocular radiolucency. OPG | Spontaneous resolution of radiolucency after 6 years due to the disruption of the cystic wall | Not mentioned | Suspected dentigerous cyst/ odontogenic keratocyst |
| 8. Tumer et al. [19] | 47/M | Unilateral | R | Subcondylar | Inverted | Swelling, pain | Large pericoronal radiolucency. OPG | Extraoral, preauricular approach | Not mentioned | Dentigerous cyst |
| 9. Wassouf et al. [20] | 49/F | Unilateral | L | Condyle | Inverted | Pain, swelling, trismus | Pericoronal radiolucency. OPG, CT | Intraoral access | Transient hypaesthesia | Dentigerous cyst |
| 10. Suarez-Cunqueiro et al. [21] | 45/M | Unilateral | R | Condyle | Inverted | Pain, swelling | | General anaesthesia, intraoral endoscopic approach | Uneventful | Dentigerous cyst |
| 11. Salmeron et al. [5] | | | | | | | | | | |
| Case 1 | 41/M | Unilateral | L | Subcondyle | Inverted | Swelling, pain, purulent intraoral secretion | Well-defined pericoronal radiolucency. OPG, CT | Extraoral, endoaural approach | Uneventful | Dentigerous cyst |
| Case 2 | 53/F | Unilateral | R | Subcondyle | Inverted | Pain, swelling, trismus | | | Uneventful | Dentigerous cyst |
| 12. Jones et al. [22] | 48/M | Unilateral | R | Ascending ramus | Horizontal | Swelling, trismus, chronic discharging sinus | Well-defined pericoronal radiolucency. CT | Intraoral, Hunsuck sagittal split ramus osteotomy followed by intermaxillary fixation | Transient paraesthesia | Radicular cyst |
| 13. Wang et al. [1] | 31/F | Unilateral | R | Ascending ramus | Inverted | Pain and swelling | Normal follicular space. OPG, CT | Intraoral access, an incision along the anterior edge of ramus and external oblique ridge | Transient paresthaesia | Dentigerous cyst |
| 14. Kupferman and Schwartz [23] | | | | | | | | | | |
| Case 1 | 49/F | Unilateral | R | Ascending ramus | Inverted | Pain, trismus, foul taste | Well-defined pericoronal radiolucency and sclerosis of the mandible. OPG, CT | Intraoral access, incision not specified | Not mentioned | Acute infection |
| Case 2 | 55/F | Unilateral | L | Ramus | Inverted | Swelling, pain, fever and trismus | Sclerosis of the mandible. CT | Intraoral access | Not mentioned | Acute infection |

(*continued*)

**Table 1.** Continued.

| Author | Age/ gender | Unilateral/ bilateral | Side right (R), left (L) | Location | Position | Clinical findings | Radiographic findings and diagnostic radiograph taken | Management | Complications | Associated lesion |
|---|---|---|---|---|---|---|---|---|---|---|
| 15. Gadre and Waknis [24] | | | | | | | | | | |
| Case 1 | 30/F | Unilateral | R | Condyle | Inverted | Pain, swelling, deviation of the mandible | Pericoronal radiolucency, OPG, lateral oblique | Intraoral access, an incision along the external oblique ridge and anterior border of the ramus | Uneventful | Cyst without any keratocystic and ameloblastic changes |
| Case 2 | 40/F | Unilateral | L | Condyle | Inverted | Pain, swelling, purulent discharge | | Intraoral access | | |
| 16. Bortoluzzi and Manfro [10] | 64/F | Unilateral | R | Subcondylar area | Inverted | Pain, swelling, purulent drainage | Small pericoronal small ill-defined radiolucency. OPG, CBCT | Intraoral access | Lingual and alveolar inferior nerves paraesthesia | Dentigerous cyst |
| 17. Pace et al [3] | 53/F | Unilateral | R | Subcondylar | Inverted | Swelling, discharge | Pericoronal radiolucency. OPG, CT | Extraoral, retromandibular approach | Temporary weakness of the mandibular branch of the facial nerve | Dentigerous cyst |
| 18. Ahmed and Speculand [7] | | | | | | | | | | |
| Case 1 | 38/F | Unilateral | L | Angle | Vertical | Recurrent pain, bad taste, facial swelling discharging sinus | Pericoronal radiolucency. OPG, CT | Extraoral Risdon neck approach | Not mentioned | Dentigerous cyst |
| Case 2 | 52/F | Unilateral | R | Sigmoid notch | Inverted | Recurrent pain, swelling, trismus, discharging sinus | | | Mild buccal branch weakness which recovered | Radicular cyst |
| Case 3 | 36/F | Bilateral | R and L | Ramus | Inverted | Swelling in bilaterally retro-molar trigone area | Bilateral pericoronal radiolucency. OPG, CT | General anaesthesia, intraoral incision bilaterally, extending up the ramus | Moderate paraesthesia of both inferior dental nerve | Bilateral dentigerous cyst |
| 19. Kim [25] | 70/F | Unilateral | R | Condylar head | Vertical | Asymptomatic | Pericoronal radiolucency. OPG, CBCT | No treatment | | Not mentioned |
| 20. Shivashankara et al. [26] | 45/M | Unilateral | L | Subcondylar | Inverted | Pain and trismus | Small pericoronal radiolucency. OPG | Extraoral Hind's incision behind the gonial region | Uneventful | Clusters of odontogenic rest cells with granulation changes |
| 21. Iglesias-Martin et al. [27] | 53/F | Unilateral | L | Subcondylar | Inverted | Pain, swelling, trismus | Pericoronal radiolucency. OPG, CT | Extraoral, retromandibular incision | Paresis of the marginal branch of the facial nerve | Dentigerous cyst |
| 22. Scott et al. [28] | 68/F | Unilateral | L | Condyle | Inverted | Facial swelling | Pericoronal radiolucency. OPG, MRI | Intraoral approach | Not mentioned | Cystic swelling of odontogenic origin |
| 23. Lee et al. [29] | 46/M | Unilateral | R | Sigmoid Notch | Horizontal | Swelling, pain | Pericoronal radiolucency. OPG, CT | Intraoral incision over the external oblique ridge and extended from the second molar to the ascending ramus. | Not mentioned | Inflamed granulation tissue |
| 24. Lambade et al. [30] | 35/F | Unilateral | L | Condyle | Inverted | Trismus, pus discharge below the ear lobule | Pericoronal radiolucency. Lateral oblique projection | Extraoral preauricular incision | Uneventful | Chronic suppurative osteomyelitis |
| 25. Goel et al. [31] | 22/M | Unilateral | L | Angle | Vertical | Swelling | Large unilocular radiolucency. OPG | Intraoral conservative marsupialization followed by enucleation | Uneventful | Dentigerous cyst |
| 26. Bowman et al. [32] | 56 /M | Unilateral | R | Subcondylar | Horizontal | Preauricular swelling | Unilocular radiolucency. OPG, CBCT | Extraoral, transmasseteric anteroparotid approach | Uneventful | Dentigerous cyst |
| 27. Kansy et al. [33] | 27/F | Unilateral | L | Ascending ramus | Vertical | Asymptomatic | Small pericoronal radiolucency. OPG, CT | An intraoral incision along the anterior border of the ascending ramus | Numbness of lip, symptoms resolved after treatment | Not mentioned |
| 28. Fındık and Baykul [34] | 45/M | Unilateral | R | Sigmoid notch | Horizontal | Asymptomatic | Pericoronal radiolucency. OPG, CBCT | An intraoral incision on the anterior edge of the ramus and external oblique ridge | Not mentioned | Dentigerous cyst |

(*continued*)

**Table 1.** Continued.

| Author | Age/ gender | Unilateral/ bilateral | Side right (R), left (L) | Location | Position | Clinical findings | Radiographic findings and diagnostic radiograph taken | Management | Complications | Associated lesion |
|---|---|---|---|---|---|---|---|---|---|---|
| 29. Apaydin and Salahattin [35] | | | | | | | | | | |
| Case 1 | 38/F | Unilateral | L | Ascending ramus | Vertical | Pain, swelling | Normal follicular space. OPG, CT | An intraoral incision on the anterior edge of the ramus along to the external oblique ridge | Slight paraesthesia | Not mentioned |
| Case 2 | 25/F | Unilateral | R | Mid ramus | Horizontal | Intense pain, swelling, pus discharge | Large unilocular radiolucency. OPG, CT | Intraoral incision | Slight paraesthesia | Dentigerous cyst |
| 30. Vij [36] | 30/F | Unilateral | L | Coronoid process | Vertical | Asymptomatic | Normal follicular space. OPG | No treatment has done | | |
| 31. Laino [37] | | | | | | | | | | |
| Case 1 | 59/F | Unilateral | R | Lower border | Vertical | Pain, swelling | Small pericoronal radiolucency. OPG, CT | Extraoral mini-submandibular access to remove the skin fistulous and tooth. | Not mentioned | Not mentioned |
| Case 2 | 48/M | Unilateral | L | Lower border | Vertical | Pain, swelling, purulent drainage | | Extraoral mini-submandibular access | Not mentioned | Not mentioned |
| 32. Adachi [38] | 58/F | Unilateral | L | Sigmoid notch | Inverted | Discomfort in the left buccal mucosa, tooth moved to sigmoid notch from ramus in 18 years | Pericoronal radiolucency. OPG, CBCT | General anaesthesia Intraoral approach, incision on the anterior edge of the mandibular ramus | Not mentioned | Granulation tissue with chronic inflammation |
| 33. Hanisch [39] | 51/M | Unilateral | R | Sigmoid notch | Inverted | Pain in the preauricular region | Pericoronal radiolucency. OPG, CBCT | General anaesthesia, an intraoral incision along the anterior edge of the mandibular ramus | Not mentioned | Chronic inflammation |
| 34. Luitel et al. [40] | 45/F | Unilateral | R | Ramus | Inverted | Asymptomatic | Pericoronal Radiolucency. OPG | No treatment has done | | |
| 35. Liau et al. [41] | 49/M | Unilateral | L | Subcondylar region | Vertical | Facial pain, swelling, trismus | Well-defined radiolucent. OPG | Endoscope assisted intraoral approach | Not mentioned | Dentigerous cyst |
| 36. Forgach et al. [42] | 51/M | Unilateral | L | Condyle | Vertical | Swelling, trismus, dysphagia, misdiagnosed as sialadenitis | Unilocular, radiolucency. CT | Endoscopic-assisted intraoral approach with a piezoelectric handpiece | Not mentioned | Dentigerous cyst |
| 37. Okuyama et al. [43] | 63/F | Unilateral | R | Subcondylar region | Inverted | Swelling, limited jaw function, pain | Pericoronal radiolucency. OPG, CBCT | Intraoral approach, incision like sagittal split ramus osteotomy | Paraesthesia of the inferior alveolar nerve and lingual nerve | Chronic infection |
| 38. Diana et al. [44] | 35/F | Unilateral | L | Ramus | Vertical | Pain, swelling trismus | Well-defined Pericoronal radiolucency. OPG, CBCT | Intraoral access, high lingual split access osteotomy | Transient paraesthesia over the labial mucosa | Not mentioned |

into four levels. Level I, seen in the upper ramus, level II in the middle ramus, level III in the mandibular angle and level IV in the mandibular body [45].

More than 50% of the EMTM teeth in our review showed an inverted angulation and nearly 80% of the EMTM teeth had lesions and a majority of the teeth with radiolucent lesions in the panoramic radiograph were confirmed histopathologically as dentigerous cysts. Therefore, the theory involving odontogenic cysts in the pathogenesis of EMTM seems to be relevant. However, the exact causes are still not understood and the involvement of other factors in the pathogenesis cannot be ruled out [27].

The majority of EMTM teeth are diagnosed because of clinical signs and symptoms and only a few are incidentally discovered during routine radiographic examination [7]. Our review found that about 85% of the cases were symptomatic. The frequently observed signs and symptoms were swelling, pain, trismus, facial asymmetry, difficulty in mastication, purulent discharge, bad taste and temporomandibular joint dysfunctions. Infrequent symptoms included sinus opening [8,14,22], dysphagia [42], ear pain and deviation of mandible [24]. One EMTM reported having dental caries suggestive of displacement of a tooth into a sigmoid notch after its exposure to the oral cavity [28]. Few cases also reported prodromal symptoms such as fever with acute inflammation and enlargement of lymph nodes [23,45]. Thus, EMTM displays a wide range of symptoms which are common to other orofacial pathologies which may lead to misdiagnosis of EMTM. The duration of clinical signs and symptoms varied from a few months to 7 years [16]. About 15% of the cases in the present review were found to be asymptomatic [15,25,33,34,36,40].

We noticed that OPG are sufficient for the diagnosis of EMTM. However, in a few of the reviewed case reports, CT and CBCT have been used for further diagnosis and treatment planning of the EMTM. The more detailed nature of CBCT can therefore be speculated to play a role during the surgical intervention as well as for virtual surgical treatment planning [10,12,27]. Additionally, small volume CBCT provides substantially more details in detecting the incidental findings in impacted canine and third molar however, majority of these findings were considered as low grade or anatomical variants with only small minority of cases (0.3%) require immediate action and in 28.5% cases require follow-up [46].

About 90% of the EMTM teeth were treated through a surgical approach. Out of them, about 65% adopted an intraoral approach and 35% of cases through an extraoral approach. The main objective of surgical treatment is to minimize morbidity without affecting the functional activities of the mandible [10]. The choice of surgical approach depends on the preference of the oral surgeon, the location of the tooth, and the associated lesion. The intraoral approach is much advocated whenever possible as it is more conservative and produces the least trauma to the patient [20]. This approach is suitable for the coronoid, ramus and sigmoid notch regions [42]. Sublingual and buccal incision were commonly preferred and in a few cases endoscopes [21,41,42], and sagittal split osteotomy [22,43] were performed. A combination of endoscopy and piezoelectric handpiece was found to be more advantageous [42]. Few authors also suggested the removal of the coronoid process for better exposure when an intraoral approach was used [1].

The extra-oral approach was most preferred for EMTM in the condylar/sub condylar, high in the ramus and lower border of the mandible areas, as these regions were the most difficult to visualize from the intraoral approach [42]. It provides better exposure of the surgical field, more control over the surgical plane, less bone removal, and helps to apply rigid fixation to prevent or treat iatrogenic fracture [22,27]. However, there will be a skin scar, a risk of damage to the marginal mandibular branch of the facial nerve, and TMJ components [1]. Infrequently, damage to the parotid capsule leading to sialocele formation was observed in one case [27]. Hunsuck sagittal split ramus osteotomy can be considered in deeply impacted EMTM and cases requiring extensive removal of alveolar bone [22]. Interestingly, one EMTM tooth with large radiolucency showed spontaneous regression over 6 years due to the decrease in the intracystic hydrostatic pressure after the disruption of the cystic wall leading to drainage and decompression [18]. About 10% of the asymptomatic EMTM teeth were not provided with any treatment. These teeth without any lesions need to be monitored with follow-up at regular intervals [1].

Our literature review showed no serious complications associated with the removal of EMTM, nevertheless, the risk of damage to nerve structures, temporomandibular joint and aesthetic aspects were reported. In cases where an extraoral approach was used, mild transient paresis of the facial nerve branches were seen which resolved after 4–6 weeks [1]. The risk of mandibular fracture and damage to the nerve increases when a limited visibility approach is chosen, and the greater osteotomy is performed [45]. Hence, it is useful to carry out osteosynthesis with mini plates for fixing bone fragments and prevent fractures in these areas. For EMTM teeth located in the condylar region, the preauricular or transmasseteric anteroparotid approach was advocated to reduce surgical morbidity and the risk of iatrogenic injury. Furthermore, EMTM teeth in the condylar region need careful attention, because the remaining bone is thin and are vulnerable to pathological fractures [1].

## Conclusions

Our review concluded that EMTM can be found at various locations in the mandible, detected after non-specific clinical signs and symptoms arise. The true prevalence of EMTM appears to be under-reported, as our systematic review included only published cases, and many asymptomatic cases may be unreported. The exact aetiology remains unknown. The cases with symptoms require surgical removal and asymptomatic cases requires annual follow-up visits with an OPG to monitor the migration or occurrence of any lesion. The decision for removal should be meticulously planned understanding the potential risk, possible complications and the benefits of the procedure by choosing the

most conservative technique that produces minimum trauma to patients.

## Disclosure statement

The authors declare no competing interests with regards to the authorship and/or publication of this article.

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