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ORIGINAL ARTICLE

The Incidence of Mandibular Second Molar Distal Caries Associated with Impacted Mandibular Third Molar: A Retrospective Study and Management Guidelines

ABDUL AZIM ASY ABDUL AZIZ[1], NORA SAKINA MOHD NOOR[2]*, NOOR HAYATI AZAMI[2], GHEE SEONG LIM[2], MYRNA NURLATIFAH ZAKARIA[2]

[1]Department of Conservative Dentistry and Prosthodontics, Faculty of Dentistry, Universiti Sains Islam Malaysia, 55100 Kuala Lumpur, Malaysia

[2]Department of Restorative Dentistry, Faculty of Dentistry, Universiti Malaya, 50603 Kuala Lumpur, Malaysia

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ABSTRAK

Salah satu komplikasi ketara gigi geraham bongsu rahang bawah (MTM) yang tidak tumbuh sepenuhnya (terimpak) ialah karies distal pada geraham kedua rahang bawah (MSM) yang akhirnya boleh menyebabkan kehilangan awal gigi tersebut. Kajian ini bertujuan untuk menyiasat kejadian karies gigi pada MSM yang mempunyai kaitan dengan MTM terimpak serta cadangan penilaian langkah pengurusan berkaitan dengan MTM. Rekod pergigian pesakit bersama gambar panoramik pergigian telah dikaji secara retrospektif, dengan sejumlah 583 imej MTM telah dinilai. Kewujudan karies distal MSM, butiran pesakit, kedalaman impaksi, corak dan sudut MTM serta jarak antara MSM distal dan MTM mesial telah dinilai. Analisis regresi logistik dijalankan ke atas set data. Insiden karies tertinggi diperhatikan pada MTM terimpak mesioangular (34.1%). Kebanyakan karies yang ditemui ialah Tahap A (27.9%) dan Kelas II (27.0%). Jarak tertinggi antara MSM distal dan MTM yang menyumbang kepada karies ialah 0.70-0.99 cm (31.9%). Umur pesakit, sudut, corak dan kedalaman MTM terimpak ialah pembolehubah yang meningkatkan insiden karies pada MSM secara signifikan ($p<0.05$). Cabutan pencegahan gigi MTM sepatutnya dicadangkan apabila jarak antara MTM terimpak mesial dan MSM distal adalah sekitar 0.70-0.99 cm, dan MTM bersudut mesial dengan klasifikasi IIA.

Kata kunci: *Cabutan pencegahan; geraham kedua bawah; geraham ketiga terimpak; karies gigi; kejadian karies*

ABSTRACT

One of the notable complications of impacted mandibular third molar (MTM) is distal caries of the mandibular second molar (MSM) which can eventually lead to its early loss. The present study aimed to investigate the incidence of dental caries in MSM associated with impacted MTM and

Address for correspondence and reprint requests: Nora Sakina Mohd Noor. Department of Restorative Dentistry, Faculty of Dentistry, Universiti Malaya, 50603 Kuala Lumpur, Malaysia. Tel: +60379676488 / +60379674814 Email: norasakina@um.edu.my

to propose an assessment protocol for MTM management. Patients' dental records with dental panoramic tomography (DPT) imaging were studied retrospectively, in total 583 MTM images were evaluated. The presence of MSM distal caries, patient's details, impaction depth, pattern and angulation of MTM and the distances between distal MSM and mesial MTM were assessed. Logistic regression analysis was performed on the data set. The highest caries incidence was observed in mesioangular impacted MTM (34.1%). Majority of the caries found were Level A (27.9%) and Class II (27.0%). The highest distance between distal MSM and MTM contributing to caries was 0.70-0.99 cm (31.9%). Patients' age, angulation, pattern and depth of impacted MTM are the predictors which significantly increase the caries incidence in MSM ($p<0.05$). Prophylactic removal of MTM should be proposed when the distance of mesial impacted MTM and distal MSM is around 0.70-0.99 cm, and is mesially angulated with IIA classification.

Keywords: Caries incidence; dental caries; impacted third molar; mandibular second molar; prophylactic removal

INTRODUCTION

Mandibular third molar (MTM) impaction is the most common type of impaction which makes up 68% of all tooth impaction cases in Malaysian population (Kashmoola et al. 2019). The known aetiology of MTM impaction is limited eruption space, genetic factor, retarded growth process and growth direction (Svendsen & Maertens 1997). The impacted MTM may be asymptomatic, but some patients may experience ulcers, pain and swelling. It also may affect the adjacent tooth, causing distal dental caries, root resorptions and periodontal defects on the mandibular second molar (MSM) (Al-Khateeb & Bataineh 2006). Some factors are known to contribute to dental caries in MSM such as, the characteristic of third molar impaction, age and oral hygiene condition. Hence, early removal of impacted MTM with early restorative procedures can minimise the morbidity associated with second mandibular molar teeth (McArdle et al. 2018).

The prevalence of MSM distal caries was 25.4% and that it was highly dependent on the severity of the impacted MTM (Marques et al. 2017). Recently, there are growing numbers of clinical studies showed a growing pattern for MSM distal caries worldwide, ranging from 5 to 51% in various demographics and care settings (Toedtling et al. 2023). Majority of MSM cases referred to restorative dentist specialist already had extensive decay and was deemed unrestorable especially in patients more than 35 years old (Chen et al. 2021). This showed that keeping the impacted MTM untreated, may result in the extraction of both the second and third molars simultaneously (Yadav et al. 2016).

Classically, prophylactic removal of the third molar is performed by oral maxillofacial surgeons before the patient develops signs and symptoms (Shepherd & Brickley 1994). However, many clinicians are not practising prophylactic MTM removal due to the risk of post-operative complications such as nerve injuries, bleeding, trismus, paraesthesia, oedema and periodontal complications (Lee et al. 2015). This is further supported by National Institute for Health and Care Excellence (NICE) guidelines which mentioned that prophylactic removal of asymptomatic impacted third molars should be discontinued, and surgical removal of impacted wisdom teeth should be limited to teeth with pathologic evidence (National

Institute for Health and Care Excellence 2000). However, the Ministry of Health Malaysia (MOH) Clinical Practice Guidelines (CPG) for the management of unerupted and impacted third molar teeth (second edition) that was published in 2021, Malaysian dentists should consider removal of MTM to reduce risk of dental caries in MSM.

The aforementioned guideline speaks of the avoidance of prophylactic removal of asymptomatic impacted wisdom tooth, but currently there is no clear guideline or recommendations in Malaysia for the indication for prophylaxis surgical removal of impacted third molars associated with distal caries in MSM. This is due to the fact that the caries prevalence in Malaysia is relatively high, with low patients' compliance and awareness whereas the prophylactic removal procedure should be reconsidered. Therefore, the aim of this study was to investigate the incidence of dental caries in the MSM associated with an impacted MTM and to propose an assessment protocol for MTM management to decide the urge of prophylactic removal of MTM.

MATERIALS AND METHODS

The present study is a retrospective cohort study looking at the correlation of dental caries incidence in MSM with an impacted MTM from dental panoramic tomography (DPT) imaging. The study has been approved by The Medical Ethics Committee of the faculty with reference number: DF RD1928/0091 (P). Extraoral radiographs images obtained from the Dental Faculty, Universiti Malaya were taken using Veraviewpocs 2D (J.Morita Corp, Japan) machine. The measurements and assessments were performed with Syngo Imaging XS VA70B_1301 radiograph viewing software, while the patients' records and details were extracted from BIT Software DEISY v5.0 Beta. Data was extracted from the Oral Maxillofacial Surgery patients' waiting list at Dental Faculty, Universiti Malaya starting from the year 2015 to 2019.

The inclusion criteria for the extra-oral radiograph samples were Malaysians over the age of 25 years at the time of enlistment with partially and fully impacted third molars. The presence of the MTMs and the adjacent, MSMs in at least one of the two quadrants is required (left or right). The exclusion criteria were MSM with restoration or the absence of the MSM, and distortion or error in the images.

Initial screening was done by excluding all the subjects that did not fulfil the inclusion criteria. A total of 4412 cases were in the data pool and sample size was calculated using the Select Statistical Services website (Daniel 1999). The sample proportion for distal caries on second molar prevalence in recent previous study (37.5%) was used to estimate the sample size (Srivastava et al. 2017). The margin of error was set at 5% with a confidence level of 95%. The recommended sample size for the whole five years was 337. Simple randomised sampling was done using the Random.org website.

Age, gender, and race of the patients were recorded as social demographic information. The reading was done triple times to ensure consistency and the intraclass correlation coefficient (ICC) test was conducted. The presence of caries was recorded from the images as radiolucent at the contact point, coronal or below the cervical region (Figure 1.1). On DPT radiograph, the surfaces were judged as either caries or caries free only (Hansen 1980). The depth of MTM (Figure 1.2) was determined from the highest portion of the MTM (Kang et al. 2016). The angulation of MTM was measured by calculating the angle formed by the occlusal surface of the third molar and the mandibular occlusal plane

(Figure 1.3), as described by Shiller (1979). The distance between the distal second molar and mesial third molar surfaces at the CEJ level of both teeth was determined by applying the Leone classification (Figure 1.4) (Leone et al. 1986).

All the readings were measured using a digital calliper reviewed in Syngo Imaging XS VA70B_1301 (Siemens Healthcare GmbH, Erlangen, Germany) and ruler (centimetres) in Syngo software with 1.3 of magnification and 1:1 of calibration ratio. Overall dental assessment was evaluated by observing the presence of decay, filling, or missing teeth from the charting in BIT Software Dental Information System (DEISY) v5.0 Beta (UM, Malaysia).

The data were analysed using Statistical Package for the Social Science (SPSS) version 23 (IBM, Armonk, USA). Patients' demographic variables and classification of impacted MTM were analysed descriptively. Chi-square analysis was performed to calculate for any significant differences in presence of caries on MSM ($p<0.05$) for the following factors: age, angulation, depth, pattern of impacted MTM and distance of distal MSM to the mesial of MTM. To evaluate the association between two quantities variables and analysing the most factor that contribute to the presence of second mandibular caries, a logistic regression test was done.

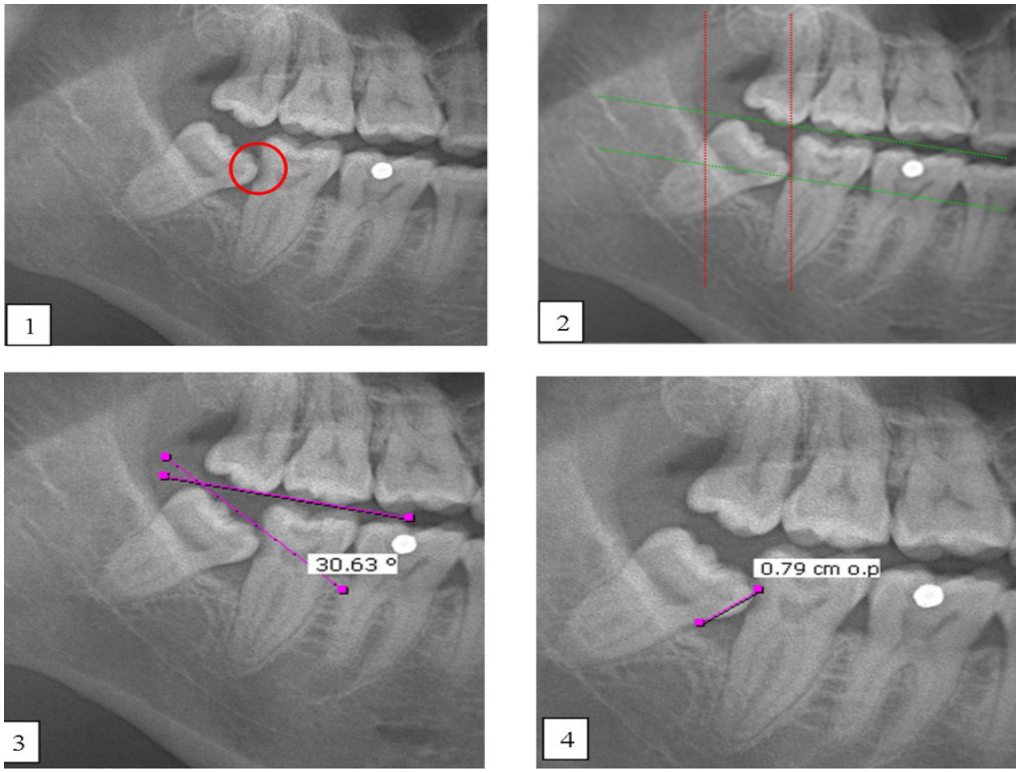

FIGURE 1: Caries and impacted MTM impaction: (1) Distal caries on MSM; (2) The depth and space of MTM was determined by the Pell & Gregory classification method; (3) The Shiller classification applied in determining the angulation of impacted third molar; (4) The distance between the distal CEJ of the MSM and mesial CEJ of the MTM was calculated as described in Leone classification

RESULTS

In total, 583 of impacted MTMs teeth from 337 patients were evaluated. Table 1 shows the summary of patients characteristics included in this study, including age, gender, and race. Majority of them were in the age of 25-29 years old (71.8%), female (59.6%), and Malay race (45.4%). Table 2 depicts the characteristics of MTM evaluated in this study. Most MTM were mesioangulated (n=267) followed by horizontal angulation (n=131) with more than half, 69.0% of the impacted depth being type A. Approximately 71.9% of the impacted pattern was classified as Class II. The highest percentage of distance from distal MSM to mesial of MTM is 38.1% in a range of 0.70-0.99 cm.

The incidence of caries on the distal of the second molar caused by the impaction of the third molar which is 24.7%. The ICC value was 0.894 (indicating good reliability) and ranges between 0.800 to 0.945. To avoid violating assumption during the Chi-square analysis, 3 groups were combined and merged (40-44, 45-49 and 50-54 years old) to only one group (>40 years old) and the variables in distance were merged between (<0.1 with 0.10-0.39) and (1-1.29 with >=1.3) while NA was removed. Age, angulation, depth, pattern of impacted MTM and distance of distal MSM to the mesial of MTM were associated to presence of caries on MSM ($p<0.05$). The frequency and percentage with Chi-square value were summarised in Table 3. The most common MTM angulation that contributes to caries incidence in MSM was mesioangulation (n=91) followed by horizontal angulation (n=42). From 144 distal caries presence in MSM, 85 cases were observed from the sample's age group (25-29 years old).

TABLE 1: Summary of patient characteristics

Variables	Classification	Frequency (n)	Percentage (%)
Age (years)	25-29	242	71.8
	30-34	55	16.3
	35-39	23	6.8
	40-44	13	3.9
	45-49	3	0.9
	50-54	1	0.3
TOTAL		**337**	**100**
Gender	Male	136	40.4
	Female	201	59.6
TOTAL		**337**	**100**
Race	Malay	153	45.4
	Chinese	135	40.1
	Indian	28	8.3
	Others	21	6.2
TOTAL		**337**	**100**

The statistical analysis proceeds with logistic regression by using the Backward Stepwise (Likelihood Ratio). The presence of caries was observed and coded as; Yes = 0 and No = 1. It underwent three iterations of removal which during the first and second iteration, pattern and distance were removed leaving age, angulation and depth as the

TABLE 2: The characteristics of mandibular third molar (MTM)

Variables	Classification	Frequency (n)	Percentage (%)
Angulation of impacted MTM	(M)=mesioangulation	267	45.8
	(D)=distoangulation	77	13.2
	(V)=vertical	90	15.4
	(H)=horizontal	131	22.5
	(O)=others	18	3.1
TOTAL		**583**	**100**
Depth of MTM, impaction from occlusal plane	A	402	69.0
	B	151	25.9
	C	30	5.1
TOTAL		**583**	**100**
Pattern of impacted MTM related to anterior border of ramus	1	108	18.5
	2	419	71.9
	3	56	9.6
TOTAL		**583**	**100**
Distance of distal MSM to the mesial of MTM (cm)	<0.10	38	6.5
	0.10-0.39	137	23.5
	0.40-0.69	91	15.6
	0.70-0.99	222	38.1
	1.00-1.29	60	10.3
	≥1.3	15	2.6
	NA	20	3.4
TOTAL		**583**	**100**

A: The occlusal plane of the MTM is at the same level as the occlusal plane of the MSM; B: The MTM occlusal plane is between the occlusal plane and the cervical margin of the MSM; C: The impacted MTM is below the cervical margin of the MSM; 1: The space is more than the mesio-distal width of the crown of the impacted MTM; 2: The distal portion of the MTM crown is covered by bone of the ascending ramus; 3: The MTM is totally embedded in the bone of the ascending ramus.

TABLE 3: The incidence of distal caries in MSM and its associations with the age and other variables

Variables	Total (n=583)	Presence of distal caries on MSM		p-value
		Yes (%)	No (%)	
Age				
25-29	424	85 (20.1)	339(79.9)	<0.001
30-34	93	35 (37.6)	58 (62.4)	
35-39	40	13 (32.5)	27 (67.5)	
40-44	22	10 (45.5)	12 (54.5)	
45-49	3	1 (33.3)	2 (66.7)	
50-54	1	0 (0.0)	1 (100.0)	
Angulation of impacted MTM				
(M)=mesioangulation	267	91 (34.1)	176(65.9)	<0.001
(D)=distoangulation	77	6 (7.8)	71 (92.2)	
(V)=vertical	90	4 (4.4)	86 (95.6)	
(H)=horizontal	131	42 (32.1)	89 (67.9)	
(O)=others	18	1 (5.6)	17 (94.4)	

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Depth of MTM, impaction from occlusal plane				
A	402	112(27.9)	290(72.1)	0.002
B	151	32 (21.2)	119(78.8)	
C	30	0 (0)	30 (100)	
Pattern of impacted MTM related to anterior border of ramus				
1	108	25 (23.1)	83 (76.9)	0.027
2	419	113(27.0)	306(73.0)	
3	56	6 (10.7)	50 (89.3)	
Distance of distal MSM to the mesial of MTM (cm)				
<0.10	38	1 (2.6)	37 (97.4)	<0.001
0.10-0.39	137	13 (9.5)	124(90.5)	
0.40-0.69	91	29 (31.9)	62 (68.1)	
0.70-0.99	222	80 (36)	142(96.4)	
1.00-1.29	60	18 (30.0)	42 (70.0)	
≥1.3	15	0 (0.0)	15(100.0)	
NA	20	3 (15.0)	17 (85.0)	

Statistically significant (*p<0.05 and **p<0.001 by Pearson's chi-square independence test between categorical variables)

best predictors that contributed to the caries incidence in MSM. The logistic equation can be written as:

y = 1.295 + 12.040(depth) + 6.428(angulation) + 14.620(age).

Final results of the logistic regression are presented in Table 4. Among all the variables, age, angulation, and depth of impacted MTM were significant predictors that contribute to the incidence of caries (p<0.05). For instance, in every unit change of depth, the presence of caries in MSM would increase 12.04 times, holding all others variables are constant. Based on our finding, we proposed an assessment protocol for MTM management to decide the urge of prophylactic removal of MTM as seen in Figure 2.

DISCUSSION

As reported by several studies, distal caries incidence varies from 7 to 32 percent in MSM

TABLE 4: Final step of logistic reggresion

Variable	B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I.for EXP(B)	
							Lower	Upper
Age	-0.417	0.109	14.620	1	0.000	0.659	Age	-0.417
Angulation	0.202	0.080	6.428	1	0.011	1.223	Angulation	0.202
Depth	0.698	0.201	12.040	1	0.001	2.009	Depth	0.698
Constant	0.393	0.346	1.295	1	0.255	1.482	Constant	0.393

Final logistic regression by using the Backward Stepwise/Likelihood Ratio (p<0.05).

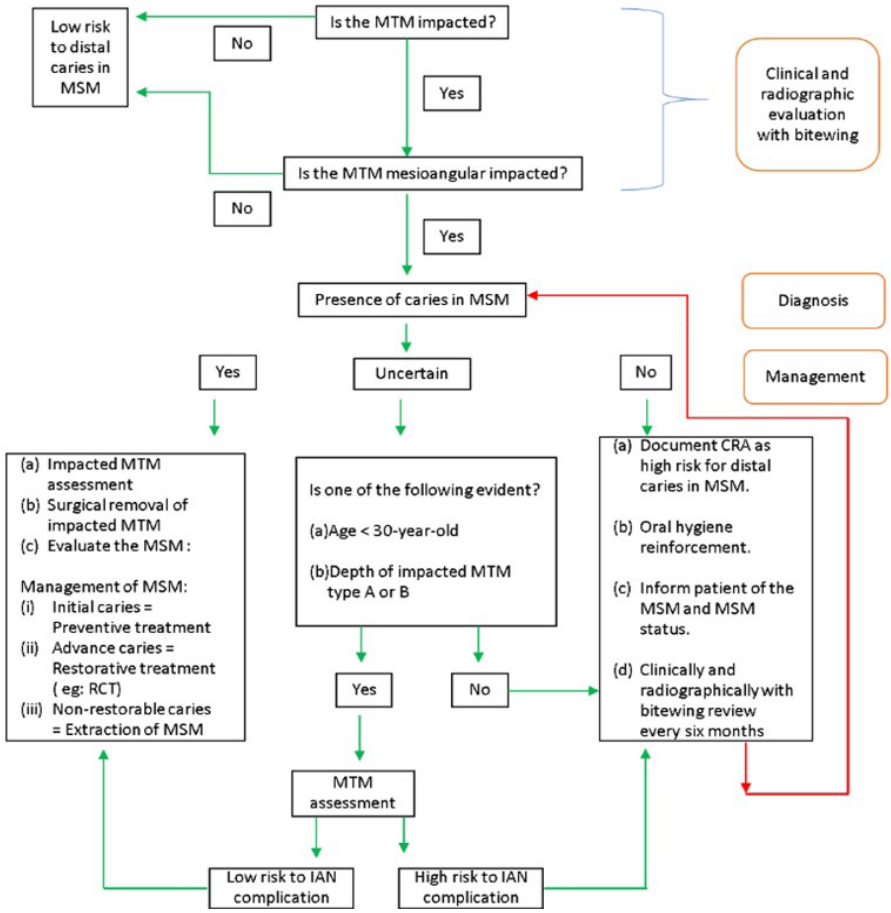

FIGURE 2: Algorithm for MSM management from assessment of the asymptomatic impacted MTM

with adjacent impacted MTM (Chen et al. 2020; Kang et al. 2016; Marques et al. 2017; Pepper et al. 2017; Toedtling et al. 2016). In accordance to that, we found caries formation on distal MSM was 24.7% which is almost similar to the previous findings reporting 25.4% and 24.4% using the same research design (Ali et al. 2017; Marques et al. 2017). However, it must be noted that the results from the present study were solely based on the DPT interpretation which was considered to have low technique sensitivity or specificity. When combined with other methods, such as cone-beam computed tomography (CBCT), the percentage of caries incidence may increase. Higher caries incidence (31.6%), was reported by a study using CBCT in diagnosing the carious lesions (Chen et al. 2020). Another previous study also reported a higher caries incidence of approximately 37.5% and it is believed that this is because the investigators used an intra-oral periapical radiograph in addition to the DPT images in their study (Srivastava et al. 2017). On a study which investigated both clinical and radiographic data and discovered 38% of caries prevalence affecting the distal aspect of MSM (Toedtling et al. 2016). Thus, the combination of methods revealed a higher

number of caries incidences.

Most of the third molars will fully erupt between the ages of 17 and 24 years. As a result, data for the present study was collected using samples from people aged 25 years and older. Therefore, it was not surprising to discover that distal caries on MSM were more prevalent in subjects over the age of 25 years (Vandeplas et al. 2020). Kang et al. (2016) claimed that patients aged 27 to 59 years were 2.18 times more likely to develop distal caries in MSMs than those aged 16 to 27 years. The present study revealed that 25-29 years age group has a significantly higher tendency to develop caries on MSM (59.0%), this was in accordance to a study that resulted in a similar view of caries prevalence of distal aspect on MSM (Syed et al. 2017). In contrary, no correlation between the increasing age and the prevalence of distal caries in MSM was also reported (Chen et al. 2020).

The MTM location is a more important factor for MSM distal caries development than other contributing factors such as general susceptibility to dental caries (McArdle et al. 2014). Distal caries in the second molar is influenced by the depth of the impacted MTM which is related to the occlusal angulation of the impacted tooth and the occlusal surface of the second molar (Ahmed 2012; Ozeç et al. 2009). The current study's logistic regression also revealed an association between depth of impacted MTM and distal MSM caries. It is two-fold higher than the angulation factor, and type A has the highest impaction from the occlusal plane (27.9%). There was no dental caries observed from type C; below the cervical margin of the MSM (fully impacted).

In the present study, highest caries incidence (63.2%) was observed in impacted MTM in mesial angulation (11-70˚) the followed by horizontal impaction (29.2%). We speculated that food impaction frequently occurs in between MSM and mesioangular with type A impacted MTM. The highest percentage of distal MSM caries associated with mesioangular impaction is 85% (Ustad et al. 2015) while in some papers stated that the percentage is 68.3%,57.5%, 51% and 70.6% respectively (Ali et al. 2017; Chen et al. 2020; Toedtling et al. 2016). According to the evidence, more than half of mesial-angular impacted MTM contributed to caries formation in distal aspect of MSM. Hence, it is proposed that mesial angulation of impacted MTM increase the severity of distal caries (Pentapati et al. 2019).

According to Pepper et al. (2017), removing mesioangularly impacted MTM reduced the risk of distal caries by 31%. Thus, the prophylactic extraction of impacted MTM is justified since it will benefit the dental health of the patient. However, the decision to extract the third molar is rarely straightforward. More research is needed to precisely identify patients who will benefit the most from prophylactic removal of mesioangularly impacted third molars in order to aid the clinicians in their decision. Based on the findings of this study, the authors conclude that the pattern of impacted MTM related to the anterior border of ramus is less critical to consider when deciding whether to remove MTM prophylactically. Marques et al. (2017) studied the justification of prophylactic removal of lower third molar. However, because it was not a significant factor, they did not include this impacted pattern in their conclusion, and the present study analysis also revealed a similar finding.

The DPT only captures two-dimension images like other conventional radiographs. Therefore, the authors suggest for more accurate interpretation, such as bitewing radiographs as it is useful for more accurate interpretation in distinguishing caries lesions involving the enamel or dentine. In some

cases, the dental caries can be asymptomatic and cannot be clinically detected in its early stages. Underestimation of caries diagnosis in MSM may result in the progression of the lesion, involving the subgingival area, root and eventually invading the pulpal system, necessitating endodontic treatment or extraction of MSM. Based on this, our findings are consistent with other researchers (Marques et al. 2017; Srivastava et al. 2017; Syed et al. 2017) who concluded that the distal caries incidence of MSM justifies the prophylactic removal of impacted MTM. The recommendation to retain asymptomatic impacted MTM by NICE in 2000 has reduced 30% of impacted MTM surgery activity. Same phenomenon was also reported by other studies (Ghaeminia et al. 2016; Renton et al. 2012). However, it could not prevent the caries from occurring in MSM. In fact, NICE conducted a study analysis comparing the long-term outcomes of asymptomatic MTM retention before and after NICE publication. According to the study, the relative chance of developing distal caries in MSM is 11 times higher.

The protocol proposed in the present study can be a helpful guide to determine if prophylactic removal of MTM is recommended. However, based on current situation which is characterised by high caries prevalence (85.1%) (National Oral Health Survey for Adults 2020) and low compliance rate (68.5%) (Mohd et al. 2021) among the Malaysian population, the authors recommend the prophylactic removal of MTM. A longitudinal study for more than five years is possible because MSM distal caries appears to be a slowly developing phenomenon that appears 5.3 years after the emergence of the MTM, particularly in mesioangularly impacted conditions. CBCT images can be used as adjunct diagnostic tools for the impacted teeth and its related structures as well as to predict higher prevalence of early caries lesion prevalence in buccal or lingual side of impacted MTM.

CONCLUSION

Prophylactic removal of MTM can be considered, particularly in young patient (25-29) when the distance of mesial impacted MTM and distal MSM is around 0.70-0.99 cm, and the impaction is mesially angulated with classification IIA. Frequent monitoring or prophylactic removal of MTM should be proposed. Therefore, before deciding to retain or remove the impacted MTM, a thorough evaluation should be performed.

Author's contribution: AAA was involved in almost level of the study especially the data collection, analysis and write-up; NS contributed to project administration and supervision; NH and GSL focused on the conceptualisation and reviewed the final manuscript; MN played important role in journal selection including editorial support.

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