

# EFFECTS OF FURCATION INVOLVEMENT ON MOLAR SURVIVAL IN PERIODONTALLY TREATED PATIENTS

Efectos de la furcación sobre la supervivencia molar en pacientes sometidos a tratamiento periodontal

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## ABSTRACT

**Objective:** This study aims to analyze the survival time of molar tooth according to furcation involvement (FI) classification among periodontally treated patients under a supportive periodontal care program.

**Materials and Methods:** A retrospective study was conducted among 77 periodontitis patients with 240 molars who had undergone periodontal therapy that were followed up with supportive periodontal therapy (SPT) for at least five years. Periodontitis patients' data were retrieved from the periodontic clinical record. The clinical parameters of all involved molars and treatment modality were recorded at baseline and SPT.

**Results:** A total of 69 (28.8%) molars were extracted during active periodontal therapy, while 17 (7.1%) were lost during SPT. The 5-year survival rate of molars was 83.5% (95% confidence interval [CI], 76.9-88.4) for FI=0 (n=141), 81.0% (95% CI, 56.9-92.4) for FI=I (n=18), 50.0% (95% CI, 33.8-64.2) for FI=II (n=21), and 25.0% (95% CI, 6.9-48.8) for FI=III (n=4). Additionally, the 10-year survival rate for molars with FI = III was 12.5% (95% CI, 1.0-39.2), which was lower than that of molars with FI = 0 (77.1%; 95% CI, 69.7-83.0).

**Conclusions:** The presence of a high degree of FI classification, especially Class III, is associated with a lower survival rate of molars among periodontally treated patients. Retention of molars is possible on a long-term basis through a maintenance program of periodontal therapy.

**Keywords:** Furcation defects; Molar; Periodontitis; Survival rate; Tooth loss; Clinical Record.

## RESUMEN

**Objetivo:** Este estudio tiene como objetivo analizar el tiempo de supervivencia de los molares según la clasificación de implicación de la furcación (IF) entre pacientes tratados periodontalmente bajo un programa de cuidado periodontal de apoyo.

**Materiales y Métodos:** Se realizó un estudio retrospectivo entre 77 pacientes con periodontitis con 240 molares que habían sido sometidos a terapia periodontal y fueron seguidos con terapia periodontal de soporte (TPS) durante al menos cinco años. Los datos de los pacientes con periodontitis se recuperaron de la Historia Clínica de Periodoncia. Los parámetros clínicos de todos los molares involucrados y la modalidad de tratamiento se registraron al inicio y en el TPS.

**Resultado:** Se extrajeron un total de 69 (28,8%) molares durante la terapia periodontal activa, mientras que 17 (7,1%) se perdieron durante la TPS. La tasa de supervivencia de los molares a 5 años fue del 83,5% (intervalo de confianza [IC] del 95%, 76,9-88,4) para FI=0 (n=141), del 81,0% (IC del 95%, 56,9-92,4) para FI=I (n=18), 50,0% (IC 95%, 33,8-64,2) para FI=II (n=21) y 25,0% (IC 95%, 6,9-48,8) para FI=III (n=4). Además, la tasa de supervivencia a 10 años para los molares con FI = III fue del 12,5 % (IC del 95 %, 1,0-39,2), que fue inferior a la de los molares con FI = 0 (77,1 %; IC del 95 %, 69,7-83,0).

**Conclusión:** La presencia de un alto grado de clasificación FI, especialmente Clase III, se asocia con una menor tasa de supervivencia de los molares entre los pacientes tratados periodontalmente. La retención de los molares es posible a largo plazo mediante un programa de mantenimiento de terapia periodontal.

**Palabras Clave:** Defectos de Furcación; Diente molar; Periodontitis; Tasa de Supervivencia; Pérdida de diente; Ficha Clínica.

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## INTRODUCTION

Molar teeth play a pivotal role in chewing, grinding, and clenching. Aside from offering support in eating, molars are also important in maintaining the facial structure and establishing balanced occlusion.

The loss of a molar tooth leads to frequent movement adjacent to or opposing the edentulous space into it to maintain a new equilibrium state.<sup>1</sup> This alteration creates a functional problem for the patient and complexity of dental treatment for the clinician, especially when multiple loss of molar teeth is involved.

The majority of the loss of molars in periodontal patients is due to periodontal problems.<sup>2</sup> Several studies documented that a significant number of maxillary and mandibular molars have been extracted due to periodontal bone loss in the furcation region.<sup>2,3</sup> A recent systematic review and meta-analysis also provided evidence to reflect that furcation involvement (FI) doubles the risk of tooth loss for molars maintained in supportive periodontal therapy (SPT) for up to 10-15 years.<sup>4</sup>

These studies highlighted that molars with FI are critical issues in periodontitis. Additionally, patient- and tooth-related factors, such as Class III furcation involvement, non-vital tooth, higher mean probing depth and bleeding on probing, age, male gender, smoking status, and diabetes were found to heighten the risk of molar loss in supportive periodontal care.<sup>3,5</sup> A recent classification of periodontal disease indicated that periodontitis is categorized based on the stages of severity (level of interdental clinical attachment loss, radiographic bone loss, and tooth loss), complexity and extent, and distribution of the condition.<sup>6</sup>

The complexity of periodontitis increases to Stage III or Stage IV when the patients present with tooth loss due to periodontitis.<sup>7</sup> Thus, tooth loss

due to periodontitis needs to be considered in managing periodontal patients as it represents an advanced stage of periodontitis.

Accumulated evidence from the literature highlights the importance of analyzing the clinical records on the loss of molar following periodontal therapies to prevent or reduce the number of tooth losses in periodontally treated patients.

This is also pertinent to achieve the ultimate aim of periodontal treatment by maintaining the tooth in a functional state. Furthermore, previous studies recommend identifying the survival of molars for at least five years after active periodontal therapy (APT).<sup>2,3</sup>

Providing evidence that periodontitis-affected molar without FI is maintainable compared to molar with FI, the molar tooth can survive with simple maintenance provided by primary care during a routine check-up. This might reduce the national economic burden associated with the management of periodontitis in Malaysia.<sup>8</sup> Given the highlighted problem, this study aimed to analyze the survival time of molar tooth according to FI classification among periodontally treated patients under a supportive periodontal care program in a government periodontic specialist setting in Kedah, Malaysia.

## MATERIALS AND METHODS

### Study Population

This retrospective cohort study was approved by the Medical Research and Ethics Committee (MREC) and registered with the National Medical Research Register (NMRR-21-174-57969). This study involved 77 periodontitis patients with 240 molars who underwent periodontal therapy between 2012 and 2022 at the Periodontic Specialist Clinic, Klinik Pakar Pergigian Kota Setar, Kedah, Malaysia.

Patients' data were retrieved from the Periodontic Clinical Record using simple random sampling.

Complete periodontal records, including full mouth periodontal charting, treatment modality, and status of the completion of APT and SPT, must be presented during the data retrieval. Thus, the Periodontic Clinical Record was chosen as it fulfilled all the inclusion and exclusion criteria.

At the patient level, the eligibility entailed patients who must have been diagnosed with periodontitis<sup>9</sup> and have been placed in a regular SPT program for at least five years after APT with at least once per year of maintenance care. The patients must have at least one molar with a probing pocket depth (PPD) of > 5 mm, including an endo-treated molar.

Meanwhile, patients with history of diabetes mellitus (diagnosed or under treatment), current or past smokers, pregnant women during baseline visits were excluded from the study.

### Periodontal Examinations and Treatment

All patients had undergone a similar protocol of periodontal treatment. All clinical parameters including dichotomous full mouth plaque score (FMPS), full mouth bleeding score (FMBS), PPD, clinical attachment level (CAL), bleeding on probing (BOP), recession, tooth mobility, and horizontal FI were measured at baseline, the first (T1), and the last of SPT (T2). Full mouth periodontal assessment was measured by using a UNC-15 periodontal probe.

The APT consisted of non-surgical and surgical periodontal treatment. In the beginning, periodontal patients were treated with non-surgical therapy, which included patient motivation, oral hygiene education/instruction, risk factor control, and professional mechanical plaque

removal (PMPR). PMPR comprised supragingival and subgingival instrumentation.

Then, the individual response was re-assessed (periodontal re-evaluation) in the following 6 to 8 weeks. Surgical interventions which include access flap, resective, and regenerative periodontal surgery were performed to treat those areas that were not responding adequately. Non-surgical treatment was also employed depending on the type and extent of periodontal destruction.

Upon the completion of APT, patients' clinical parameters were re-evaluated (T1). The patients were placed under the SPT program which comprised periodontal review at an individualized interval of 3-12 months per year.

The SPT consisted of a combination of preventive and therapeutic interventions, which include patients' motivation and reinforcement of oral hygiene instructions, clinical measurements, PMPR, and localized subgingival instrumentation at residual pockets. In any periodontal treatment (APT/SPT), tooth extraction was considered if the molar tooth was decided with a poor prognosis.<sup>10</sup> In this study, T2 was considered the data of patients' clinical parameters after 5 years of the first SPT. Additionally, the degree of furcation<sup>11</sup> and treatment modality of all involved molars were recorded during APT and SPT with scaled Nabers color-coded probes. In the case of the different stages of FI in one tooth, the most severe furcation involvement was recorded.

### Sample size determination

Sample size estimation was calculated based on a previous study using PS software. According to Dannewitz *et al.*,<sup>3</sup> the mean survival time for molars with furcation involvement degree III following supportive periodontal treatment was 11.8 years, and the true hazard ratio (relative risk) of molars with FI degree III relative to molars

without probable furcation was 4.68. With a probability (power) of 0.8, type I error probability of 0.05, and accrual interval (follow-up period from recruitment) of 13.2 years, this study requires a total of 40 subjects to be able to reject the null hypothesis.

### Statistical analysis

All the data analyses were performed using R statistical software, Version 3.5.2. Categorical variables were described as frequencies and percentages, whereas numerical variables were reported as means and standard deviations.

Tooth loss was considered the main outcome variable. The calculation of tooth loss was calculated by recording the total number and percentage of molar tooth loss during APT and SPT with the time recorded.

The Kaplan-Meier survival analysis was applied to estimate the survival probabilities of a molar tooth. All probability values were two-sided and a *p*-value <0.05 was considered statistically significant.

## RESULTS

### Patient and molars characteristics

A total of 77 patients with 240 molars fulfilled the inclusion criteria at the beginning of the periodontal therapy. The patients' mean age was 50.2 years. More than half of the patients were female (67.5%) and 50.6% were Chinese. The mean follow-up for the periodontal therapy was approximately 95 months. Of 240 molars examined, 139 (57.9%) were maxillary molars and 101 (42.1%) were mandibular molars.

There was a slightly higher proportion of first molars (51.3%; *n* = 123) than second molars (48.8%, *n* = 117). Most molars had no probable furcation entrances (degree 0), whereas 21 mo-

lars exhibited a FI of degree I (8.8%), 40 of degree II (16.7%), and 15 molars had degree III (6.2%). Table 1 and 2 summarize the patients' and molars' characteristics.

### Active Periodontal Therapy (APT)

Table 3 depicts the frequency distribution of the various therapeutic procedures in terms of molar type and furcation involvement (FI) during APT. All molars received periodontal treatment during APT. Most molars (55.8%) received root surface debridement (RSD), which was commonly performed on degree 0 of FI.

On the other hand, 69 molars (28.8%) were extracted during the APT of which 31 were subjected to flap surgery (11.7%). Resective therapy was performed in six molars (2.5%), regenerative therapy in two molars (0.8%), and only one molar had tunnelling surgery (0.4%).

The commonest reason for molar extraction during APT was periodontitis (59.3%), followed by the endodontic-periodontal lesion (EPL) (31.4%), and dental caries (9.3%).

### Molar loss

Table 4 depicts the frequencies of molars loss during the periodontal therapy and the corresponding furcation involvement. A total of 86 molars were lost during the study with maxillary molars accounting for the loss of 59 teeth, whereas 27 mandibular molars were lost. Of these molars, 39 had no probable furcation (degree 0), 6 had a degree I FI, 29 had a degree II, and 12 had a degree III.

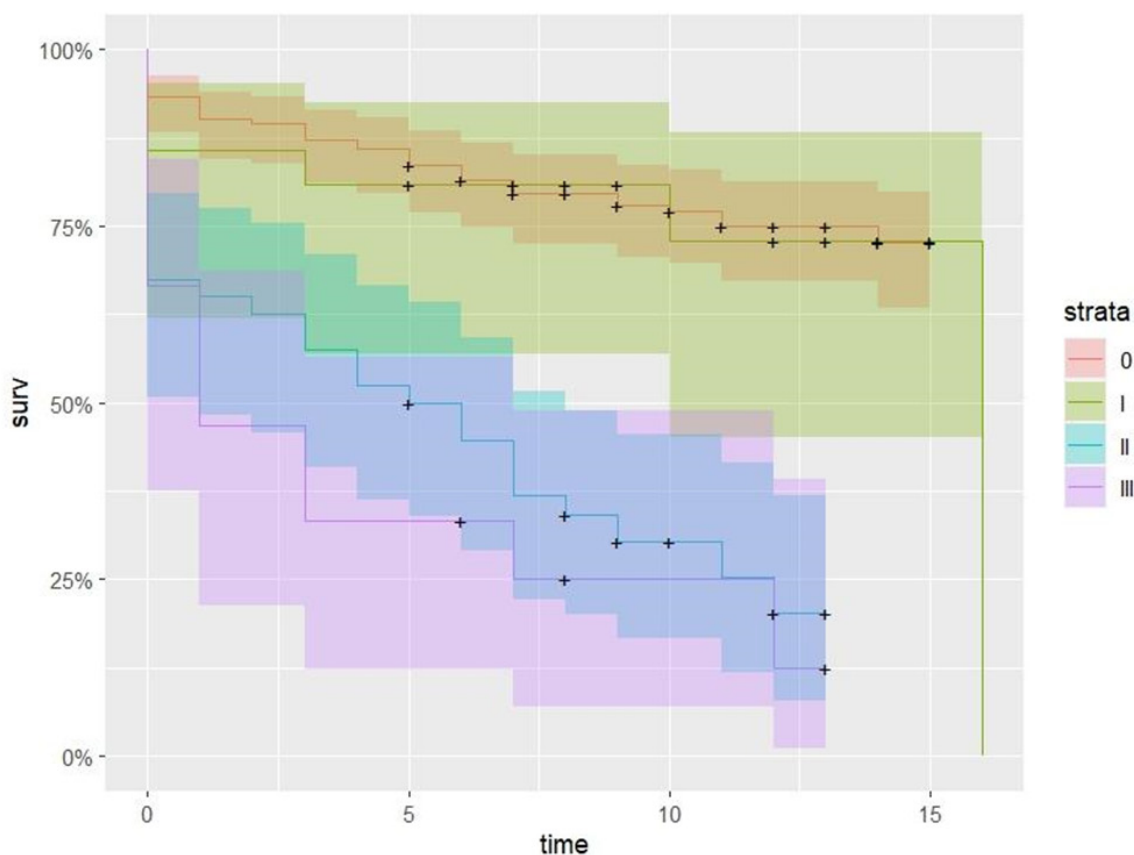
### Survival of molar tooth

The Kaplan-Meier estimates of the 5-year survival rate of molars (Table 5 and Figure 1) were 83.5% (95% confidence interval [CI], 76.9-88.4) for FI=0 (*n*=141), 81.0% (95% CI, 56.9-92.4) for FI=I (*n*=18), 50.0% (95% CI, 33.8-64.2) for FI=II (*n*=21), and 25.0% (95% CI, 6.9-48.8) for FI=III (*n*=4).

The 10-year survival rate for molars with an FI classification degree of III was 12.5% (95% CI, 1.0-39.2), which was lower than that of molars with an FI classification degree of 0 (77.1%; 95% CI, 69.7-83.0).

A statistically significant difference was found ( $p < 0.001$ ) upon using the log-rank test to compare the survival rates of molars according to four different FI classification degrees.

**Figure 1.** Kaplan Meier survival curve of molars according to furcation involvement classification degree.



**Table 1.** Demographic data of the patients included in the study.

CHARACTERISTICS		N	(%)
Age (years), mean		50.2	12.36
Gender	Male	25	32.5
	Female	52	67.5
Ethnicity	Malay	36	46.8
	Chinese	39	50.6
	Indian	2	2.6
Number of Teeth, mean		26.5	3.43
Treatment Follow-up (months), mean		94.8	38.1

**Table 2.** Molar characteristics of the patients included in the study.

MOLAR CHARACTERISTICS			N	(%)
Type of molar and position	Maxillary	First molar	80	33.3
		Second molar	59	24.6
	Mandibular	First molar	43	17.9
		Second molar	58	24.2
Furcation involvement classifications	Degree 0		164	68.3
	Degree I		21	8.8
	Degree II		40	16.7
	Degree III		15	6.2

**Table 3.** Type of treatment for molar tooth and the furcation involvement during Active Periodontal Therapy (APT).

FURCATION INVOLVEMENT	THERAPY	MAXILLARY MOLARS (N = 139)		MANDIBULAR MOLARS (N = 101)		TOTAL MOLARS
		First	Second	First	Second	
0	Root Surface Debridement	34	26	21	30	111
	Open Flap Debridement	4	4	5	8	21
	Resective	0	0	0	1	1
	Tunnelling	0	0	0	0	0
	Guided Tissue Regeneration	0	0	0	1	1
	Extraction	10	13	2	5	30
I	Root Surface Debridement	7	0	3	2	12
	Open Flap Debridement	0	1	1	0	2
	Resective	0	0	0	1	1
	Tunnelling	0	0	0	0	0
	Guided Tissue Regeneration	1	0	0	0	1
	Extraction	1	1	0	3	5
II	Root Surface Debridement	2	4	2	3	11
	Open Flap Debridement	4	0	0	0	4
	Resective	2	0	0	0	2
	Tunnelling	0	0	0	0	0
	Guided Tissue Regeneration	0	0	0	0	0
	Extraction	12	9	1	1	23
III	Root Surface Debridement	0	0	0	0	0
	Open Flap Debridement	0	0	0	1	1
	Resective	2	0	0	0	2
	Tunnelling	0	0	1	0	1
	Guided Tissue Regeneration	0	0	0	0	0
	Extraction	1	1	7	2	11
<b>Total</b>	<b>Root Surface Debridement</b>	<b>43</b>	<b>30</b>	<b>26</b>	<b>35</b>	<b>134</b>
	<b>Open Flap Debridement</b>	<b>8</b>	<b>5</b>	<b>6</b>	<b>9</b>	<b>28</b>
	<b>Resective</b>	<b>4</b>	<b>0</b>	<b>0</b>	<b>2</b>	<b>6</b>
	<b>Tunnelling</b>	<b>0</b>	<b>0</b>	<b>1</b>	<b>0</b>	<b>1</b>
	<b>Guided Tissue Regeneration</b>	<b>1</b>	<b>0</b>	<b>0</b>	<b>1</b>	<b>2</b>
	<b>Extraction</b>	<b>24</b>	<b>24</b>	<b>10</b>	<b>11</b>	<b>69</b>

**Table 4.** Molar tooth loss during periodontal therapy and the corresponding furcation involvement.

FURCATION INVOLVEMENT (DEGREE)	TOOTH LOSS	MAXILLARY MOLARS (n = 139)		MANDIBULAR MOLARS (n = 101)		TOTAL MOLARS
		First	Second	First	Second	
0	Yes	13	14	4	8	39
	No	35	29	24	37	125
I	Yes	2	1	0	3	6
	No	7	1	4	3	15
II	Yes	16	10	1	2	29
	No	4	3	2	2	11
III	Yes	2	1	7	2	12
	No	1	0	1	1	3
<b>Total</b>	<b>Yes</b>	<b>33</b>	<b>26</b>	<b>12</b>	<b>15</b>	<b>86</b>
	<b>No</b>	<b>47</b>	<b>33</b>	<b>31</b>	<b>43</b>	<b>154</b>

**Table 5.** Median survival time and survival rate of molars at 5- and 10-year according to furcation involvement classification degree.

VARIABLES	MEDIAN (95% CI)	SURVIVAL RATE (%)		X <sup>2</sup> (df)	p-value*
		5-YEAR	10-YEAR		
Furcation Involvement (degree)				64.6 (3)	<0.001
0	NOT AVAILABLE	83.5	77.1		
I	16.0 (10, NOT AVAILABLE)	81.0	72.9		
II	5.5 (1, 8)	50.0	25.3		
III	1.0 (0, 7)	25.0	12.5		

**Survival analysis using the Kaplan-Meier method. Median:** median survival time in years; **CI:** Confidence interval. **x<sup>2</sup>:** chi-squared; **df:** degrees of freedom. **\***: Log-rank test.

## DISCUSSION

The present investigation demonstrated a significantly higher prevalence of furcation-involved molars in the maxilla compared with the mandible. This finding coincides with the previous reports.<sup>14-16</sup>

In contrast, a study among the Japanese population revealed that the mandibular first molar

recorded the highest prevalence of molar with FI.<sup>17</sup>

The factors contributing to the variations in the prevalence of molars with FI include geographical locations, ethnicity, and anatomical variations of the molar teeth among the populations.<sup>18</sup> The frequency of non-surgical therapy decreased with increasing degrees of FI. As highlighted in the literature review, it can be



difficult to accurately assess, diagnose, and treat a molar with furcation defects due to challenges in terms of anatomical and morphological variations. The difficulties may also stem from limited physical access for root instrumentation to reach the depths of the furcation and the measurement errors that occur during the diagnosis and treatment planning.<sup>19</sup>

During APT, 84 out of a total of 321 molars were extracted. Hamp *et al.*,<sup>11</sup> reported 114 extractions out of 284 molars (40.1%) during APT. In contrast, 26.1% of the molars were extracted during APT and 33% during the complete observation period in the present study. Nevertheless, a direct comparison of the studies evaluating tooth loss during periodontal therapy is difficult. If a high proportion of the teeth with a questionable prognosis are extracted during active treatment, fewer teeth loss will more likely be observed during subsequent maintenance and vice versa.<sup>20</sup>

In this study, the evaluation of different treatment modalities during APT relative to the degree of FI revealed that tooth extraction was most frequently performed in molars with degrees II and III. This result aligns with the report by Wang *et al.*,<sup>20</sup> (1994) in which molars with FI recorded a higher number of clinical attachment loss and tooth loss than non-furcated teeth.<sup>21</sup>

The survival rates of molars in comparison to the degree of FI were calculated excluding the third molars. Molars with FI of degree III at the onset of active therapy had a significantly inferior survival rate compared to the other molars. These findings are consistent with a previous study, which found the survival curve of teeth with degrees II and III FI had a statistically significant inferior survival rate over the averaged follow-up of 9.97 years (with a maximum of 16 years).<sup>22</sup> These results are also in tandem with a recent study in which the ten-year survival of molar with class II furcation involvement was 52.5%.<sup>23</sup>

Nonetheless, the latter study only focused on tooth retention of degree II FI and the survival rates were classified in terms of vertical sub-classification.<sup>23</sup>

Molars with degree III (or through-and-through) FI represent a challenge from a therapeutic standpoint, which resulted in a higher risk of being extracted. In this study, one of the treatment modality was tunneling surgery. Previous study concluded that this option was not suitable for patients who not undergoing regular SPT.<sup>24</sup>

This study has several limitations. A retrospective study design is prone to selection, performance, and reporting bias. This study design was chosen as a prospective study is often not feasible to assess the long-term outcome of tooth loss. Moreover, future investigations should consider additional patient-reports and include radiographic findings.

By adding radiographic analysis, the effect of both horizontal and vertical furcation involvement on molar survival could be analysed.<sup>25</sup> Another limitation of this study is alternating practitioners with different levels of periodontal skills. This might have also affected the accuracy of probing horizontal attachment loss within the furcation and assignment to FI degree.<sup>26</sup>

Accurate diagnosis of FI is fundamental for decision-making and assessing the prognosis of diseased molars.<sup>27,28</sup>

## CONCLUSION

In conclusion, overall periodontal therapy results in a good prognosis of molars for at least five years. The presence of a high degree of FI classification, especially Class III is associated with a lower survival rate of molars among periodontally treated patients. Retention of molars is possible on a long-term basis through a maintenance program of periodontal therapy.



## CONFLICT OF INTERESTS

The authors declare that they have no conflicts of interest.

## ETHICS APPROVAL

Approved by the Medical Research and Ethics Committee (MREC) and registered with the National Medical Research Register (NMRR-21-174-57969).

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## AUTHORS' CONTRIBUTIONS

**Yusof NAM and Yahaya R:** Conceptualization, data collection.

**Suan MAM:** Data analysis.


**Yusof NAM:** Writing – original draft, review and editing.

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## PEER REVIEW

This manuscript was evaluated by the editors of the journal and reviewed by at least two peers in a double-blind process.

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