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Original research

Evaluation of third molar agenesis associated with hypodontia and oligodontia in turkish pediatric patients

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Purpose
To evaluate the association between third molar (M3) agenesis and hypodontia and oligodontia in pediatric patients by using panoramic radiography.

Materials and Methods
Panoramic radiographs of 1,471 patients (899 females; 572 males) and 5,884 teeth were retrospectively evaluated. The age and gender of the patients were recorded. Patients ages 9-15 years old were included in the study. The mean age was 12.76. The agenesis of M3 teeth and the relationship between M3 agenesis and hypodontia and oligodontia were recorded according to findings from the upper and lower jaw, in both the right and left locations, along with the number of M3 with agenesis. Data were analyzed using chi-square and McNemar tests ($p<0.05$).

Results
A total of 1,319 (89.7%) patients had all M3 teeth present in the mouth, while the other 152 (10.3%) had congenital agenesis in one or more teeth. The number of teeth in which M3 agenesis was seen, in order of the number of missing M3 teeth, the percentages were 2.6% for one, 2.4% for two, 1.0% for three and 4.3% for four missing teeth.Hypodontia was detected in 37 patients and oligodontia was detected in 3 patients.

Conclusion
The prevalence of M3 agenesis varies from one population to another. Two of the dental anomalies associated with M3 agenesis are hypodontia and oligodontia. In this study, M3 agenesis varied in terms of region and gender; hypodontia was also significantly higher in patients with missing mandibular M3.

Keywords: *Hypodontia; Oligodontia, Panoramic radiography, Third molar agenesis, Tooth loss*

Introduction

Tooth agenesis is defined as congenitally missing one or more teeth in deciduous or permanent dentition. These teeth are unerupted and radiologically invisible (1). Currently, about 50% of the third molar (M3) teeth have some form of anomaly that may be impacted or partially erupted. However, they may be absent in the oral cavity (2). Formation time, crown and root morphology of each are widely variable (3).

Tooth agenesis is one of the dental anomalies that is most commonly observed in dentition. Hypodontia is defined as the absence of one to five teeth, excluding the M3. Oligodontia is defined as the absence of six or more teeth, excluding the M3. Anodontia is an extraordinary situation presenting the total absence of teeth (4-6). The most commonly observed tooth agenesis is M3 agenesis which can occur idiopathically or with a syndrome (7). Habitual eating changes in human evolutionary development can cause structural changes to the teeth and jaw (8). To explain the congenital absence of different tooth groups, several hypotheses have been proposed for many years.

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However, in the etiology of congenital tooth absence, environmental, local, systemic and genetic factors can be efficient (9). Reports have been made about mutations in some genes which are effective in the growth and development process; reports have also been made about non-syndromic or familial cases of congenital tooth agenesis (10).

The time of development, calcification and eruption of M3 are highly variable. The minimum age of the development germ formation of M3 teeth is 6 years according to the literature although the mean age of development is 8 or 9 years (11,12). Calcification can begin at the age of 7 years in some cases and up to 16 years. The formation of enamel is generally finalised between the age of 12 and 18 years while root formation is generally finalised between the age of 18 and 25 years (13).

In most of studies, the eruption criteria was the emergence of any crown part through the oral cavity. This can reveal incorrect results because many of the M3 don't continue to erupt but remain impacted as a partially erupted situation (14). However, the M3 is the last to erupt and is seen in the intra-oral cavity within the permanent dentition. Additionally, it is reported that the most common congenital tooth agenesis is detected in M3 in about 15-20% of cases (15).

On the other hand, the agenesis of M3 may be associated with some numerical dental and morphological anomalies (16). In the literature there are widely variable results about the frequency of M3 agenesis. It was reported that the agenesis of other teeth was observed 13 times more with the agenesis of M3 (17).

There may also be characteristic differences in societies as well as individuals in terms of congenital dental anomalies. Tooth agenesis varies from one continent to another and between genders. In this context, given the large population of young individuals who live in the Thrace region of Turkey, detection of whether there are significant deficiencies with respect to the development of M3' germs and identification is important. This is especially true regarding the association of M3 agenesis with other permanent teeth that are missing and the variations of agenesis localizations. The use of radiological evaluations is important for gaining epidemiological insights. The aim of this study was to evaluate the prevalence and distribution of M3 agenesis and the relationship between M3 agenesis and hypodontia and oligodontia in a population of Turkish pediatric patients.

The null hypotheses investigated were (1) the prevalence of M3, hypodontia and oligodontia, regardless of the distributions of teeth, would present with significantly different rates in terms of gender and (2) there would not be a significant relationship between M3 and other congenital permanent tooth agenesis.

Materials and Methods

After the ethical committee approval of the Trakya University Medical Faculty (Protocol number: TÜTF-BAEK 2018/134), the study was started. The patients who were referred to the Faculty of Dentistry for various reasons during the years 2015 through 2017 were randomly selected. Panoramic radiographs of 1,471 patients (899 females; 572 males) were retrospectively evaluated. Patients' gender and age were noted. Patients over 15 years old, patients with systemic and congenital disease, or any pathology in the jaws and poor quality of radiographs were excluded from this study.

M3 agenesis, hypodontia and oligodontia were evaluated as missing teeth that had no detectable germs on panoramic radiographs. The panoramic radiographs of healthy children who presented for routine dental examinations were obtained. All radiographs were taken using a panoramic radiography machine (PaX-Flex; Vatech Inc., NJ) (50–90 kV, 4–10 mA and 10.1 s exposure time) by the same technician-for standardization.

Each radiograph was digitally analyzed. One observer was responsible for evaluation of the panoramic radiographs. One observer checked 50 radiographs twice during a period of two weeks to estimate Intraclass Correlations (ICC).

Statistical analysis

The Statistical Package for Social Science (SPSS) 20.0 software program (SPSS Inc., Chicago, IL, USA) was used for evaluation of the study data. The percentage distribution, mean (±) and standard deviation were studied for the descriptive statistics. The chi-square test was applied for the analysis of categoric variables, but for comparisons of maxilla-mandible and right-left side agenesis, chi-square test was not suitable because these groups belonged to same patients, so they were dependent. For these comparisons the McNemar test was applied. Independent samples T-test was used to test the relationships of hypodontia and oligodontia with the number of missing M3 teeth. A p value above 0.05 was considered as not significant.

Results

The reliability was estimated by ICC for all observations. ICC indicated excellent reliability for intra-observer evaluations.

In this study, 1,471 patients in the age range of 9 to 15 (12.76±1.72) years and the panoramic radiographs of 5,884 teeth were examined; 899 of the patients (61.1%) were females and 572 (38.9%) were males. As shown in the panoramic radiography, 1,319 (89.7%) patients had all M3 teeth present in the mouth, while the other 152 (10.3%) had congenital agenesis in one or more teeth. The number of teeth that M3 agenesis was seen in, in order of the number of missing teeth, was one (2.6%), two (2.4%), three (1.0%) and four (4.3%) (Graph 1). When M3 missing teeth were analyzed by gender, despite congenital agenesis being seen more in males than females, the difference was not significant

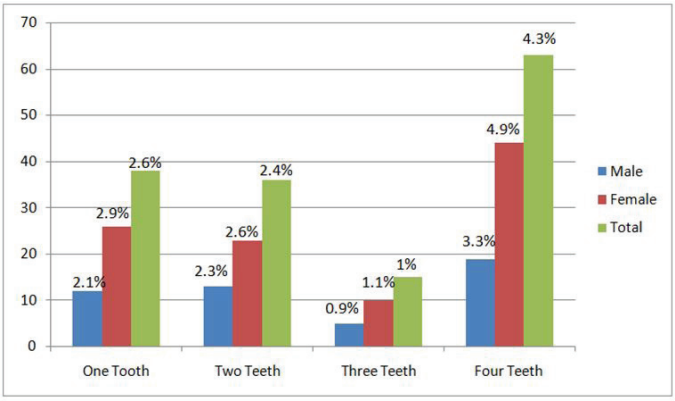

Figure 1. *Distribution of M3 agenesis by gender according to the number of missing teeth.*

(p=0.076). Also, when analyzed separately for the number of missing M3 teeth (one, two, three or four) by gender, the differences were not significant (p=0.943) (Table 1).

The most common M3 tooth agenesis was observed in the upper left region (7.2%), followed by the lower-right (7.1%), upper-right (6.9%) and lower-left (6.5%). With regard to the relationship between gender and these teeth, the differences were not significant (p>0.05) (Table 2).

Table 1. *Distribution of M3 tooth agenesis according to teeth, gender, and age. The numbers in parentheses indicate percentages*

		M3 teeth agenesis n(%)				
Age	**Gender**	**18**	**28**	**38**	**48**	**Total number of M3 teeth agenesis**
9	**Male**	5	5	5	5	20
	Female	7	8	7	7	29
	Total	12 (24.5)	13 (26.5)	12 (24.5)	12 (24.5)	49 (12)
10	**Male**	3	3	3	3	12
	Female	2	2	2	2	8
	Total	5 (25.0)	5 (25.0)	5 (25.0)	5 (25.0)	20 (4.9)
11	**Male**	6	4	3	5	18
	Female	4	5	6	6	21
	Total	10 (25.6)	9 (23.1)	9 (23.1)	11 (28.2)	39 (9.6)
12	**Male**	3	2	2	2	9
	Female	11	10	13	12	46
	Total	14 (25.5)	12 (21.8)	15 (27.2)	14 (25.5)	55 (13.5)
13	**Male**	6	8	10	9	33
	Female	20	21	17	21	79
	Total	26 (23.2)	29 (25.9)	27 (24.1)	30 (26.8)	112 (27.5)
14	**Male**	6	6	8	6	26
	Female	16	15	11	13	55
	Total	22 (27.2)	21 (25.8)	19 (23.5)	19 (23.5)	81 (19.9)
15	**Male**	3	4	1	3	11
	Female	9	13	8	10	40
	Total	12 (23.5)	17 (33.3)	9 (17.7)	13 (25.5)	51 (12.6)
9-15	**Male**	32 (24.8)[a]	32 (24.8)[b]	32 (24.8)[c]	33 (25.6)[d]	129 (31.7)
	Female	69 (24.8)[a]	74 (26.6)[b]	64 (23.0)[c]	71 (25.6)[d]	278 (68.3)
	Total	101 (24.8)	106 (26.0)	96 (23.6)	104 (25.6)	407

[a,b,c,d]Differences between gender. p[a]=0.124, p[b]=0.057, p[c]=0.248, p[d]=0.121.

The state of missing M3 teeth was examined according to maxilla and mandible; agenesis was slightly higher in the maxilla compared to the mandible.The difference was not statistically significant (p=0.640) (Table 2).

The total numbers of missing teeth in the maxilla and mandible were found 207 (7.0%) and 200 (6.8%), respectively. The total number of missing M3 teeth was 205 (7.0%) in the lower and upper-right side of the jaws, while it was 202 (6.9%) in the lower and upper-left side.The difference was not statistically significant (p=0.871).

One-hundred fifty-two patients who had congenital agenesis of M3 teeth were evaluated for hypodontia and oligodontia (Figures 1, 2). Hypodontia was detected in 37 (24.3%) pa-

Figure 1. *Hypodontia with M3 agenesis on panoramic radiographs.*

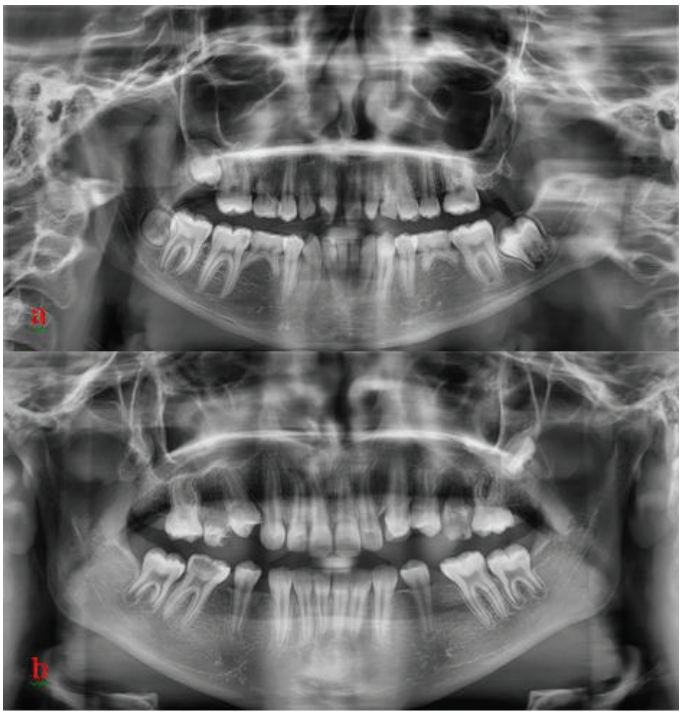

Figure 2a,b. *Oligodontia with M3 agenesis on panoramic radiographs.*

Table 2. *The rates of M3 agenesis in the maxilla–mandible and on the right-left sides of the jaws. The numbers in parentheses indicate percentages*

Gender	**Maxillary (18-28)**		**Mandibular (38-48)**		**Right side (18-48)**		**Left side (28-38)**	
n (%)	Present	Absent	Present	Absent	Present	Absent	Present	Absent
Male	1080 (36.7)	64 (2.2)	1079 (36.7)	65 (2.2)	1079 (36.7)	65 (2.2)	1080 (36.7)	64 (2.2)
Female	1655 (56.3)	143 (4.8)	1663 (56.5)	135 (4.6)	1658 (56.3)	140 (4.8)	1660 (56.4)	138 (4.7)
Total	2735 (93.0)	207[a] (7.0)	2742 (93.2)	200[a] (6.8)	2737 (93)	205[b] (7)	2740 (93.1)	202[b] (6.9)

[a,b]Differences between total number of absence of M3. `a` for maxilla and mandibula, `b`for right and left side. p[a]=0.640, p[b]=0.871

tients and oligodontia was detected in 3 (2%) patients. We didn't find a significant relationship between oligodontia and missing individual (18,28,38,48), maxillary (18-28), mandibular (38-48), right (18-48) or left (28-38) M3 teeth (p>0.05).

There was no significant relationship between hypodontia and missing upper left or upper right M3 teeth (p>0.05) but we found that hypodontia was significantly higher in patients with missing lower left (p=0.003) or lower right (p<0.001) M3 teeth.

There was no significant relationship between hypodontia and missing right (18,48), left (28,38), maxillary(18,28) M3 teeth (p>0.05). However, we found that hypodontia was significantly higher in patients with missing mandibular (38,48) M3 teeth (p=0.001) (Table 3).

The percentages on how many hypodontia/oligodontia cases were observed when one, two, three or four M3 were congenitally absent were shown in Table 3. As the number of missing M3 teeth increased, the probability of hypodontia increased as expected (p = 0.004), but no significant relationship was found with the presence of oligodontia (p = 0.653).

Table 3. *The rates of hypodontia and oligodontia according to M3 tooth agenesis. The numbers in parentheses indicate percentages*

	Hypodontia	Oligodontia
Missing 18	25 (24.8)	2 (2)
Missing 28	27 (25.5)	3 (2.8)
Missing 38	31 (32.3)*	2 (2.1)
Missing 48	34 (32.7)**	3 (2.5)
Missing Maxillary (18-28)	28 (23.7)	2 (1.8)
Missing Mandibular (38-48)	35 (31.0)***	1 (2.6)
Missing Right side (18-48)	35 (26.5)	2 (1.5)
Missing Left side (28-38)	35 (26.1)	3 (2.2)
1 missing M3	4 (10.5)	1 (2.6)
2 missing M3	7 (19.4)	0 (0)
3 missing M3	5 (33.3)	0 (0)
4 missing M3	21 (33.3)	2 (3.2)

*(p=0.003), **p<0.001, ***p=0.001.

Discussion

In this study based on panoramic radiographs, we attempted to describe the prevalence of M3 agenesis and to evaluate the relationship between M3 agenesis and hypodontia and oligodontia. Different results were found in the literature about the prevalence of M3 agenesis (Table 4).

Contrary to the findings from our study, in the studies of Mishra et al. (18), Kaur et al. (19) and Upadhyaya et al. (20), M3 agenesis was found more frequently in males. The female predilection was similar to that reported by Sandhu and Kaur (21) and Sujon et al. (16). There was no statistically significant difference between genders and this finding from our study is in concordance with other reports (22-26). Therefore, the first null hypothesis could be rejected regarding M3 agenesis.

Celikoglu et al. (27) and Mishra et al. (18) reported that the missing of all M3 teeth was more frequently found than the presence of M3 teeth, similar to the findings of this study. In the study of Mishra et al. (18), upper right M3 agenesis had the highest prevalence while lower left M3 agenesis had the lowest prevalence. But, in this study, lower right M3 agenesis had the highest prevalence. Sujon et al. (16) reported the frequency order of M3 agenesis as 1>2>4>3 while Endo et al. (28) reported the number order of M3 agenesis as 2>1>4>3. Moreno et al. (29) reported that the frequency order of M3 agenesis as 1>2>3>4. In our study, the frequency of number of M3 agenesis were noted as 4>1>2>3.

Sandhu and Kaur (21), Kaur et al. (19), Sujon et al. (16), John et al. (7) and Singh et al. (30) reported that M3 agenesis was significantly more frequent in the maxilla than in the mandible. Singh et al. (30) reported that instances of M3 agenesis were more frequent on the right side. In our study, maxillary M3 agenesis was slightly frequent. Slightly lower than the results from our study (right: 13.9%; left: 13.7%), Kilinç et al. (31) reported that the rate of M3 tooth agenesis was 12.7% and 11.2% on the right side and left side, respectively and M3 agenesis was more frequently observed in the upper-right tooth (15.1%), followed by the upper left (13.5%), lower-right (10.2%) and lower-left (8.9%) M3 teeth. It can be said that these rates were higher than those of this study. In the study of Mishra et al. (18), there were higher results compared to our study. It was reported that upper right, lower right, upper left and lower left M3 agenesis was 57.8%, 64.1%, 62.5% and 68.1%, respectively.

In the study of Sujon et al. (16), hypodontia prevalence was reported as 3.1%. This result was lower than ours. Garn et al. (17) reported that one or more instances of M3 agenesis increased the incidence of other missing teeth by 13 times. Endo et al. (28) also reported a study presenting significant increases in the occurrence of oligodontia and M3 teeth agenesis except only one M3 agenesis compared with the control group. Contrary to this study, in our study, no significant increase was observed between oligodontia and the number of missing M3 teeth.

Tompson et al. (32) found that M3 agenesis in females is significantly associated with the agenesis of the hypodontia. Endo et al. (28) reported that the prevalence rates of hypodontia cases were increased as the severity of M3 agenesis increased. Celikoglu et al. (27) also observed that the prevalence of hypodontia cases was significantly higher in patients with agenesis of three or four M3 teeth. Our study supports the idea of higher number of missing M3 teeth was associated with the presence of hypodontia.

Gulati et al. (33) reported that hypodontia cases had a higher prevalence rate in the M3 agenesis than the control group which included the patients without M3 agenesis. Similarly, in our study, hypodontia was significantly higher in patients with missing lower left or lower right and mandibular M3 teeth. But, there was no significant relationship between oligodontia and missing individual (18,28,38,48), maxillary (18-28), mandibular (38-48), right (18-48) or left (28-38) M3 teeth. Therefore, the second null hypothesis could be confirmed only regarding the relationship between M3 agenesis and oligodontia.

Panoramic radiography can exhibit not only the missing and impacted teeth, but also the size and morphologic changes and the other anomalies of the teeth (34). Panoramic radiography is important in the diagnosis of real

Table 4. *The previous studies about M3 agenesis*

Author name	Country	Year	Sample size	Population	Prevalence	Predilection
Nanda (35)	America	1954	200	White women	9.1%	Maxilla
Levesque et al. (36)	Canada	1981	4640	French-Canadian (Only mandibular M3)	9% (bilateral M3 prevalence)	-
Mok and Ho (22)	Singapore	1996	786	Singoporean-Chinese patients aged 12-16	28.5%	Maxilla
Rozkovcová et al. (37)	Czech Republic	2004	1000	Patients aged 12-21	22.5%	Male
Lee et al. (38)	Korea	2009	1129	Patients aged 16-24	41%	Female
Celikoglu et al. (8)	Turkey	2010	351	Orthodontic patients aged 20-26	17.3%	Female
Kazanci et al. (39)	Turkey	2010	2579	East Anatolian patients aged 12-16	23.8%	Maxilla
Celikoglu and Kamak (25)	Turkey	2012	1046	Orthodontic patients aged 13–17	22.7%	Maxilla
John et al. (7)	Malaysia	2012	734	Patients aged 10-19	26.2%	Female/Right maxilla
Kaur et al. (19)	India	2012	500	Patients aged 18-25	35.4%	Male/Right maxilla
Sujon et al. (16)	Malaysia	2016	5923	Patients aged 10-50	38.4%	Female/Maxilla
Kilinç et al. (31)	Turkey	2017	772	Patients aged 12-18	23.3%	Right maxilla
Mishra et al. (18)	India	2017	301	Patients aged 9-15	36.8%	Male/Maxilla
Singh et al. (30)	India	2017	300	Patients aged 18-25	46.7%	Female/Maxilla
Moreno et al. (29)	Chile	2019	535	Patients aged 14 and older	12.89%	Female/Right Maxilla
Gulati et al. (33)	India	2019	472	Patients aged 13-28	19.2%	-
The present study	Turkey		1471	Patients aged 9-15	10.3%	Maxilla

hypodontia and oligodontia cases. At the M3 teeth evaluations, the main advantages of panoramic radiography are easily observed in the situation of developing M3 teeth, the relationship between it and the mandibular canal, impaction type and M3 region (19). So, this modality was preferred because radiographic evaluation provided more accurate results than clinical examination and it could be sufficient by itself. In our study, panoramic radiographs were taken in the routine examination for diagnostic purposes in order to prevent patients from receiving extra doses.

Conclusion

There are different results from different populations and also different regions of Turkey about M3 agenesis reported in the literature. With this study, further research may provide significant contributions for the studies involving M3 agenesis and accompanying dental anomalies.

Türkçe Özet: *Türk Pediatrik Hastalarda Hipodonti ve Oligodonti ile İlişkili Üçüncü Molar Agenezisinin Değerlendirilmesi. Amaç: Pediatrik hastalarda üçüncü molar (M3) agenezisi ile hipodonti ve oligodonti arasındaki ilişkiyi panoramic radyografi kullanarak değerlendirmektir. Gereç ve Yöntemler: 1.471 hastanın (899 kadın; 572 erkek) ve 5.884 dişin panoramic radyografileri retrospektif olarak değerlendirildi. Hastaların yaşları ve cinsiyetleri kaydedildi. Çalışmaya 9-15 yaş arası hastalar dahil edildi. Ortalama yaş 12,76'idi. M3 diş agenezisi ve M3 agenezisi ile hipodonti ve oligodonti arasındaki ilişki, hem sağ hem de sol lokasyonda üstve alt çene bulgularına göre M3 agenezisi olan diş sayısı ile birlikte kaydedildi. Veriler Ki-Kare ve McNemar testleri kullanılarak analiz edildi (p <0.05). Bulgular: Toplam 1.319 (% 89,7) hastanın tüm M3 dişleri ağızda varken, diğer 152 (% 10,3) hastanın bir veya daha fazla dişinde konjenital agenezisi vardı. M3 agenezinin görüldüğü diş sayısı, eksik M3 diş sayısı sırasına göre yüzdelik olarak bir diş için %2,6, iki diş için %2,4, üç diş için %1,0 ve dört diş için %4,3'idi. 37 hastada hipodonti, 3 hastada oligodonti tespit edildi. Sonuç: M3 agenezisinin prevalansı bir popülasyondan diğerine değişmektedir. M3 agenezisi ile ilişkili diş anomalilerinden ikisi hipodonti ve oligodontidir. Bu çalışmada, M3 agenezisi bölge ve cinsiyete gore farklılık göstermektedir; hipodonti, eksik mandibular M3 olan hastalarda anlamlı olarak daha yüksek bulunmuştur. Anahtar Kelimeler: Hipodonti, Oligodonti, Panoramik radyografi, Üçüncü molar agenezis, Diş kaybı*

Ethics Committee Approval: Ethical approval was obtained from the Trakya University Medical Faculty (Protocol number: TÜTF-BAEK 2018/134).

Informed Consent: Informed consent was waived due to the retrospective nature of this study.

Peer-review: Externally peer-reviewed.

Author contributions: MTA participated in designing the study. MTA participated in generating and gathering the data for the study. MTA and NO participated in the analysis of the data. MTA and GS wrote the majority of the original draft of the paper. MTA, NO and GS participated in writing the paper. All authors approved the final version of this paper.

Conflict of Interest: The authors had no conflict of interest to declare.

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