ORIGINAL ARTICLE

Prevalence of Malocclusion and Dental Anomalies in Tanzanian Orthodontic Patients

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ABSTRACT

Background: Dental anomalies often result in malocclusion, and may complicate orthodontic treatment. Information about the relationship between dental anomalies and malocclusion is scarce. The current study aimed to examine the prevalence of malocclusion and dental anomalies in Tanzanian orthodontic patients.

Methods: This was an analytical cross-sectional study, involving orthodontic patients. Clinical and radiographical examinations were done to all participants. The relationship between malocclusion and dental anomalies was assessed by using a Chi-square test. The *p-value* for statistical significance was set at $p<0.05$, with 95% Confidence Interval.

Results: A total of 390 orthodontic patients were enrolled. Majority of the participants (55.9%) were between 12-18 years**.** Most of the participants had Class I malocclusion (85.6%). Overall prevalence of dental anomalies was 45.9%, with 37.4% having one dental anomaly and 8.5% having more than one. Ectopic eruption was the commonest dental anomaly (observed in 18.2% of participants), it was recorded more in males (24.3%) than in females (14.9%) *(p=0.02)*, and more in younger than in older participants (24.8% versus 10.5%, *p=0.01*). Tooth impaction was the second commonest anomaly (observed in 11.8% of the participants), it was recorded more in younger patients (15.6%) than in older ones (7.0%) *(p=0.01)*. The dental anomalies had no significant associations with malocclusion.

Conclusion: Most of the participants had Class I malocclusion, almost half had at least one dental anomaly. More males than females had ectopic eruptions, and more younger participants than older ones had tooth impaction. There was no significant association between malocclusion and dental anomalies. Clinicians should consider the occurrence of dental anomalies, when managing orthodontic patients.

INTRODUCTION

Malocclusion is defined as the aberration of normal occlusion in the intra and/or intermaxillary relation/s of the teeth or jaws.[1] The aetiology of malocclusion is multifactorial.[2] There is a possibility that malocclusion and dental anomalies, share common

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genes.[3] Literature have further suggested that dental anomalies can occur due to interruptions of genetic, epigenetic or environmental factors.[4] The epigenetic modifications, such as demethylation and histone modifications, have been linked with the development of dental anomalies which affect the number, shape and size of teeth.[5] Also, other environmental factors such as diet, use of chemicals and pharmaceuticals drugs, have been reported to negatively impact the dental developmental patterns.[6] In a systematic review and meta-analysis, it was indicated that 56% of the world population had malocclusion, among these 81% and 72% are from Africa and Europe, respectively.[7] Of the malocclusion, Angle's Class I, II, and III malocclusion have been found to occur in 46.5% (7.4–84.0%), 25% (0.8–72.1%) and 7 % (0.5–39.1%) of the individuals, respectively.[8] The African population mostly present with Class I malocclusion, while Class III malocclusion are the least.[9, 10]

The prevalence of dental anomalies has been reported to range from 5.6% to 60.7%,[11, 12] which can be explained by variations in sample sizes, diagnostic criteria and ethnic backgrounds of the studied populations. Notably, dental anomalies often cause malocclusion and hence are of a concern in orthodontic practices. Furthermore, anomalies can affect the patients' aesthetics and speech.[4] In addition, malocclusion can affect individual's oral function and oral hygiene.[2] It should further be considered that; dental anomalies may complicate orthodontic treatment and thus their early management can improve treatment and the treatment outcomes. This is in terms of aesthetics and oral function achievements.[13, 14] The diagnosis of dental anomalies involves clinical and radiographical examinations.[15] Whereas, their management requires a multidisciplinary approach, such as a combination of orthodontic treatment, dental prosthesis, dental restorations and surgery.[4]

Worldwide, there are inconsistencies in the reporting of associations between malocclusion and dental anomalies. This may be due to the variations in sample sizes, ethnicity and diagnostic criteria.[16, 17, 18, 19] As a result, some studies have reported presence of an association[20, 21] and others have reported absence of an association.[22, 23] Similarly, in most African studies the prevalence of having either dental anomalies or malocclusion have been documented.[18, 19, 24] Nonetheless, there was no retrievable information of the relationship between malocclusion and dental anomalies together. Hence, this study aimed to obtain the prevalence of malocclusion and dental anomalies in Tanzanian orthodontic patients.

MATERIALS AND METHODS

This was an analytical cross-sectional study, involving 390 orthodontic patients who attended at the dental clinic of the Muhimbili University of Health and Allied Sciences (MUHAS). This is a teaching facility which is in Dar es Salaam region of the United Republic of Tanzania. Orthodontic patients normally take Orthopantomography prior to orthodontic treatment. Patients aged 12 to 35 years who attended for orthodontic treatment for less than 6 months participated in the study. This age group was chosen because majority of patients attending for orthodontic treatment at the MUHAS dental clinic, are usually in this age range. In addition, most of the patients' permanent teeth are already in occlusion. The prevalence of all forms of malocclusion in Tanzania is 61.2%.[25] Therefore, the sample size estimation was done based on p=0.61, with precision of 0.05 for 95% confidence level. Participants were conveniently selected for the study, whereby; all patients who met the inclusion criteria were included, to mitigate any possible selection bias. Nevertheless, this was a hospital-based sample and so its limitation is linked to its failure to represent the entire community. Also, all orthodontic patients who attended at the MUHAS dental clinic with congenital anomalies such as cleft lip and palate, down's syndrome, ectodermal dysplasia and cleidocranial dysostosis, were excluded from the study.

Malocclusion in the sagittal plane was studied based on the molar relationship.[26] Malocclusion was classified according to Angle's Class I, Class II division 1, Class II division 2 and Class III malocclusion. For more analyses, the malocclusion

was further categorized as Class I and a combination of Classes (II and III). The combination of Classes II and III, was because both classes are potentially genetically influenced. Then the investigation of patients' digital panoramic radiographs was done using the dental clinic's desktop computer, the required information was taken from the AFYA PLUS system, which is the patients' hospital digital management system used at the MUHAS dental clinics. The information from the computers was able to confirm the clinical assessment findings and to assess the presence of anomalies that could not be ascertained clinically. The research assistant was present to record all the clinical findings in clinical forms.

Dental anomalies diagnostic criteria

The diagnostic criteria for the dental anomalies were according to Tunis *et al.*[27] which described *ectopic eruption* as the malposition of the permanent tooth due to a deficiency of space in the arch. It was scored as present when the tooth was located mesially, distally, buccally or palatally. *Hyperdontia* was scored as present when there was an increase in the regular number of permanent teeth due to the development of additional teeth. *Hypodontia* was scored as being present when there was an absence of the development of one or more permanent teeth. *Macrodontia* was scored when there was a tooth that was physically larger than normal teeth. *Microdontia* was scored as present when there was a tooth smaller than the average normal size, or its contralateral homologous. *Retained deciduous* was scored as present when there was a failure of the primary tooth to exfoliate at the proper developmental stage (more than one year late to eruption of its permanent successor). *Tooth impaction* was present when there was a tooth that failed to erupt to the occlusal or incisal level, due to a clinical or radiographic-detected barrier. *Tooth transposition* was when there was an interchange of the tooth position between two permanent teeth of the same quadrant in the dental arch. *Fusion* was present when there was a union between two separate tooth buds during dental development, involving the crowns and/or the roots. *Talon cusp* present when there was a developmental disorder, characterized by the presence of an accessory cusp at the cingulum or the cementoenamel junction.

Validity

A pilot test was done among 39 orthodontic patients, who were examined clinically and radiographically to determine presence/absence of dental anomalies and the malocclusion of interest, before the main study. The modified diagnostic criteria by Tunis were used.[27] The patient's clinical and radiographic findings which were examined by the Principal Investigator (PI) for dental anomalies and malocclusion. They were also re-examined by an experienced orthodontist (Gold standard) for standardization of the scores. Furthermore, the PI was trained by the experienced orthodontist, on a routine clinical orthodontic examination of orthodontic patients at the MUHAS dental clinic.

Reliability

Data collection was carried out by one examiner, who was the PI of the current study. A total of 39 orthodontic patients were investigated, and their findings were recorded by a research assistant. The same patients were recalled after 3 weeks for re-examination and the findings were recorded again.[26] Determination of the Kappa values was done, where the degree of agreement ranged from 0.7 - 1 for the dental anomalies, which was apposite.

Data analysis

Data was analysed by using an SPSS software version 27.0. The descriptive statistics for socio-demographic variables, including mean, Standard Deviation (SD), and the frequencies of dental anomalies and malocclusion were obtained. Then, the individual dental anomalies were summed up in both the upper jaw and the lower jaw. This resulted in a sum index of the individual anomalies, which provided the frequency of the anomalies. Furthermore, the sum of all sum indices of the dental anomalies provided the overall frequency of dental anomalies. The frequency distribution revealed the participants with one, two or more anomalies. The overall presence of dental anomalies was found from the dichotomized value of the presence or absence of the dental anomalies. The presence of malocclusion

was scored, the variable was first coded into Class I, II and III with the frequency for each Class displayed, then the variable was recorded into presence/absence of malocclusion. Chi-square test was done to determine the associations between social demographic characteristics (age and sex) and dental anomalies, as well as malocclusion. At the *p-value* of $p<0.05$ an association was considered to be statistically significant; the Confidence Interval was set at 95%.

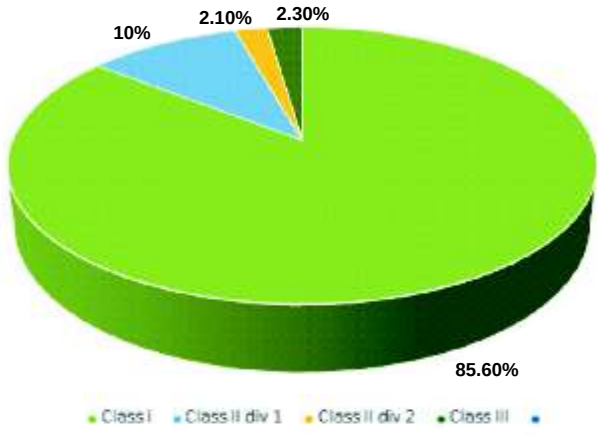
Ethical issues

Ethical clearance was obtained from the MUHAS' ethical committee of the Directorate of Research and Publication (DRP). Informed consent was attained from all the participants aged 18 years and above, while assent was sought from patients below 18 years, which was followed by a consent from the parent, guardian or caretaker.

RESULTS

A total of 390 orthodontic patients were examined, the mean age was 19.5 years ± 6.4.

Figure 1: Percentage distribution of malocclusion among the study participants.



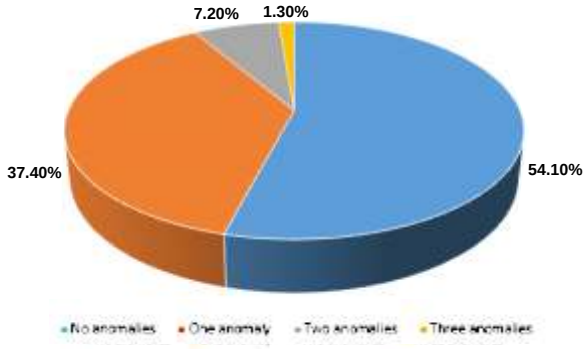
A large number of the participants had Class I molar relationship (85.6%), followed by Class II division 1 (10%), Class II division 2 (2.1%), Class III (2.3%) (Figure 1).

Table 1: *Percentage distribution of the study participants by the types of dental anomalies (N=390).*

Dental anomalies	Variables	Number (n)	Percentage (%)
Tooth size anomalies	*Microdontia*	40	10.2
	Macrodontia	5	1.3
Tooth number anomalies	*Hyperdontia*	5	1.3
	Hypodontia	18	4.6
Tooth eruption anomalies	*Ectopic eruption*	71	18.2
	Tooth impaction	45	11.8
	Retained deciduous teeth	12	3.1
Tooth position anomaly	*Tooth transposition*	5	1.3
Tooth shape anomalies	*Peg lateral*	14	3.6
Total		390	100

The distribution of different types of dental anomalies, ectopic eruption had the highest proportion (18.2%), followed by tooth impaction (11.8%) and microdontia (10.2%). On the other hand, macrodontia, hyperdontia and tooth transposition had the lowest proportions, affecting 1.3% of the participants for each anomaly (Table 1). None of the participants was found with either talon cusp or fusion.

Figure 2: Distribution of the study participants by the number of dental anomalies



A greater proportion of patients had only one dental anomaly (37.4%), few had two dental anomalies (7.2%) or three dental anomalies (1.3%). But, more than half of the participants (54.1%) had no dental anomaly (Figure 2).

Table 2: Distribution of the participants' dental anomalies and malocclusion, by age and sex.

Variables		***Sex***			***Age groups***		
Dental anomalies	**Categories**	Male % (n)	Female % (n)	*p- value*	Young %(n)	Adult %(n)	*p- value*
Tooth size anomalies	*Microdontia*	8.1 (12)	11.6 (28)	*0.27*	6.9 (15)	14.5 (25)	*0.01*
	Macrodontia	2 (3)	0.8 (2)	*0.31*	1.8 (4)	0.6 (1)	*0.28*
Tooth number anomalies	*Hyperdontia*	1.4 (2)	1.2 (3)	*0.92*	2.3 (5)	0	*0.05*
	Hypodontia	2.7 (4)	5.8 (14)	*0.16*	5 (11)	4.1 (7)	*0.65*
Tooth eruption anomalies	*Ectopic eruption*	24.3 (36)	14.9 (36)	*0.02**	24.8 (54)	10.5 (18)	*0.01**
	Tooth impaction	11.5 (17)	12 (29)	*0.9*	15.6 (34)	7 (12)	*0.01**
	Retained deciduous teeth	2.7 (4)	3.3 (8)	*0.74*	4.1 (9)	1.7 (3)	*0.18*
Tooth position anomaly	*Tooth transposition*	2 (3)	0.8 (2)	*0.31*	1.4 (3)	1.2 (2)	*0.85*
Tooth shape anomaly	*Peg lateral*	4.1 (6)	3.3 (8)	*0.7*	2.8 (6)	4.7 (8)	*0.32*
Malocclusion	*Class I*	85.1 (12)	86 (208)		86.7 (18)	84.3 (145)	
	Class II &III	14.9 (22)	14 (34)	*0.82*	13.3 (29)	15.7 (27)	*0.5*
Total		148	242		218	172	

**Statistically significant (p<0.05)*

Table 2 shows the distribution of participants' dental anomalies and malocclusion, by age and sex. There were more males (24.3%) with ectopic eruptions than females (14.9%), the difference was statistically significant (*p=0.02).* In addition, significantly many younger participants compared to the older ones, were found with impacted teeth (15.6% versus 7.0%, *p=0.01),* and ectopically erupted teeth (24.8% versus 10.5%, *p=0.01).* Malocclusion was not statistically significantly associated with either age (*p=0.5),* or sex (*p=0.82).*

Table *3*: Percentage distribution of the study participants by malocclusion and individual/overall dental anomalies.

Dental anomalies	***Malocclusion***				*p-value*
	Class I % (n)	95 % CI	Class II & III % (n)	95%CI	
Tooth size anomalies	11.7 (39)	8-15.6	10.7 (6)	4-21.9	*0.84*
Tooth number anomalies	6.6 (22)	4-9	1.8 (1)	0.00-9.55	*0.13*
Tooth eruption anomalies	31.4 (103)	26-36	19.6 (11)	10.2-32.4	*0.09*
Tooth position anomalies	0.9 (3)	0.00-2.6	3.6 (2)	0.44-12.3	*0.15*
Tooth shape anomalies	3.6 (12)	1.87-6.2	3.6 (2)	0.44-12.3	*0.68*
Sum-scores of dental anomalies					
Present	47.9 (160)	42.4-53.4	33.9 (19)	21.8-47.8	
Absent	52.1 (174)	46.6-57.6	66.1 (37)	52.1-78.2	*0.05*
Total	100 (334)		100 (56)		

Table 3 shows percentage distribution of the study participants by malocclusion and individual as well as the sum-score of dental anomalies. Compared with those with combined Class II and III, a higher proportion of participants with Class I malocclusion had tooth size anomalies (10.7% versus 11.7%, *p=0.84*), tooth number anomalies (1.8% versus 6.6%, *p=0.13*), tooth eruption anomalies (19.6% versus 31.4%, *p=0.09*). The differences were not statistically significant *(p>0.05)*. Considering the sum-scores of dental anomalies, a higher proportion of those with Class I malocclusion had dental anomalies compared with those with combined Classes (Class II and III) (47.9% versus 33.9%). The difference was statistically insignificant (*p=0.05)*.

DISCUSSION

The current study aimed to assess the prevalence of malocclusion and dental anomalies among orthodontic patients, attending a selected hospital facility in Tanzania. It is the first one to assess the prevalence of malocclusion as it relates to having dental anomalies, in a sample of Tanzanian orthodontic patients. This being a hospital-based study; all clinical and radiographic examinations were done using hospital facilities and equipment, making the measurements more precise. Nonetheless, the findings should be interpreted with caution, as they cannot be generalized to the whole community. Since a convenience sample was employed, there is a possible chance that those who

were taken had similar characteristics and may have caused a bias. However, everybody who met the inclusion criteria and consented, was included to participate in the study. This tends to offset the anticipated researcher selection bias or participant volunteering bias. Much as the hospital serves as a national referral hospital, most orthodontic patients could be coming from nearby places, and hence the sample could be limited with respect to the varieties of ethnic and racial groups. Thus, it can be hard to control for the effect of race and ethnicity, on the presence/absence of a malocclusion or a dental anomaly among the participants. Generally, in Africa there is limited data which have reported on the occurrence of malocclusion and dental anomalies. So, the current study has added an important information in the existing African data.

As regards malocclusion, most patients (85.6%) had Class I malocclusion, compared with those who had either Class II or Class III malocclusion. This finding is high, but it agrees well with the global prevalence of malocclusion, which has been reported to be 56 % (95% CI 11-99).[7] In addition, Class I malocclusion are generally the commonest among orthodontic patients.[28, 10] However, a lower prevalence of orthodontic patients with Class I malocclusion has been reported in a study which was done in Iran and in a systematic review.[12, 8] The observed variations in the prevalence of malocclusion can be explained by diagnostic criteria and racial differences. Furthermore, it could be due to the fact that malocclusion can be caused by multiple genes and environmental factors such as presence of dental caries, detrimental oral habits and early loss of teeth.

Regarding the prevalence of dental anomalies, almost half of the participants had at least one dental anomaly. This prevalence is in line with the reported global range of 5.6%–60.7%.[11, 12] Additionally, similar findings were reported in Saudi Arabia and Egypt.[22, 29] However, a lower prevalence was reported in Croatia, Nigeria and in another Egyptian study.[13, 30, 19] It is largely understood that, the variation of the prevalence of dental anomalies, may depend on the sample size and the number of dental anomalies assessed. In studies which were done in Iran and Saudi Arabia, a higher prevalence was reported.[12, 31] The diagnostic criteria, race or genetic makeup, could be the factors responsible for the disparities.

In this sample, the commonest dental anomaly was ectopic tooth eruption. This finding is like those obtained in studies which were done in Brazil, Egypt and Israel, but differs from those reported in studies from Turkey and Iran.[21, 19, 27, 26, 12] The differences observed can be explained by environmental factors such as an early tooth loss or genetic factors such as racial variances. Considering environmental factors, an early loss of a primary tooth might have occurred among the patients, causing tooth-arch-length discrepancies. This often result into a tooth being ectopically erupted or impacted.[19]

Slightly more than ten percent had tooth impaction (excluding third molars). This finding agrees with those obtained by Egyptian studies, a Sudanese study and a Saudi Arabian study.[19, 29, 32, 33] In contrast, another Saudi Arabian study obtained a higher prevalence.[31] Yet, a relatively lower prevalence was reported in Italy, France and Croatia.[34, 35, 13] The variations in the prevalence of tooth impaction in these studies, can be explained by the differences in the sample sizes utilized[31, 32, 33], the diagnostic criteria used (such as inclusion/exclusion of third molars)[31] and other related environmental factors[29, 32], such as experiencing a dental trauma or having dental caries.

As regards tooth size anomalies, the most common one was microdontia, it occurred in 10.2% of the participants. The finding is comparable to those obtained from studies which were done in India and Yemen.[36, 37] Nevertheless, a lower prevalence was reported in two Egyptian studies, and in a Turkish study .[19, 29, 26] The dissimilarities in the prevalence of the tooth size anomalies, can be explained by genetics such as inheritance of small teeth from one parent, and the disparities in the diagnostic criteria used.

Presently, dental anomalies in terms of problems related to the number of teeth and congenitally missing teeth, were found in 4.6% of the participants. This prevalence is within the previously reported range of 0.0–18.6%, and is comparable to those obtained from a Nigerian and a Turkish study.[8, 30, 38] In contrast, the current reported prevalence of hypodontia was lower compared to those found in studies which were done in Kenya and Sudan, as well as in Saudi Arabia.[39, 40, 31] The observed variations, can be explained by genetic differences of the populations studied, such as inheritance of genes responsible for the numbers of teeth.

The association between dental anomalies and age as well as sex was currently explored. While, the overall presence of dental anomalies was not associated with either sex or age, some of the individual dental anomalies were associated with those variables. This finding is like that found in a study which was done in India.[28] Specifically, ectopic tooth eruption was associated with age and sex. Whereby, many male participants had ectopic teeth eruption. This finding is in contrast with those obtained from studies which were done in Brazil, Turkey and Nigeria.[21, 26, 41] Furthermore, many younger participants compared with the older ones, had ectopic teeth eruption and impacted teeth. This can be due to the effect of an early loss of a primary tooth on one's tooth-arch-length, resulting into either an ectopic tooth eruption or a tooth impaction.[19] On the other hand, studies which were done in Brazil, Turkey and Israel, reported that there were no associations between presence of dental anomalies and ages of their participants.[21, 26, 27] In addition, the inconsistencies in the findings can be due to disparities in the diagnostic tools used, the types of dental anomalies assessed, and the racial differences.

In the present study, there was no association between malocclusion and dental anomalies (either individual or the sum-score of dental anomalies). This can be explained by the fact that majority of the participants in this sample had Class I malocclusion. It should further be noted that, the dental anomalies were currently categorized into their presence or absence. This might have as well influenced the findings obtained. Moreover, the genetic link between malocclusion and dental anomalies has also been reported in literature, where, an association between Class II div 2 malocclusion and congenital dental anomalies was found.[20] Additionally, this finding is similar to those obtained from studies which were done in Saudi, India and Turkey.[22, 23, 26] However, it differs from those obtained in studies which were done in Germany and Brazil, which reported existence of an association between malocclusion and dental anomalies.[20, 21]

CONCLUSION

Most of the participants had Class I malocclusion, almost half had at least one dental anomaly. More males than females and younger participants had ectopic teeth eruption. Also, more younger participants than older ones had impacted teeth. There was no significant association between malocclusion and dental anomalies. Clinicians should consider the occurrence of dental anomalies, when managing orthodontic patients.

What is already known on this topic: The prevalence of malocclusion is high in most of the world's populations.

What this study adds: The study revealed the prevalence of malocclusion and dental anomalies, as well as their associated factors, in Tanzanian orthodontic patients.

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Authors' contributions

MM conceptualized the study, collected data, developed and conducted the statistical analysis and wrote the manuscript draft. FM and MMM provided guidance in the whole process of designing the study data collection and manuscript writing. All authors read, agreed and approved the final manuscript.

Declarations

Ethical approval and consent to participate

Ethical approval was obtained from the MUHAS Higher Degrees Research and Publications Committee via letter Ref. No. DA.282/298/01.C/2171 of 22/04/2024. Data collection was conducted under the ethical standards and informed consent was obtained from the participants.

Conflict of interest

The authors declare no conflict of interest.

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