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Research Article

Analysis of Malocclusion and its Characteristics in the Referred Free State Orthodontic Patients

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Abstract

Background: Planning and provision of orthodontic services may require some baseline epidemiological data with regards to the distribution of malocclusion and its severity within a given population.

Aim: To analyze the distribution of malocclusion and its occlusal characteristics in Black patients referred to the Free State orthodontic clinic with regards to age, gender and Angle's malocclusion.

Materials and Method: Study models of 391 orthodontic patients (235 female and 156 male) with the mean age of 15.4 years were analyzed to determine the distribution of malocclusion using Angle's classification and other occlusal characteristics such as overjet, overbite, open bite, crossbite and the degree of incisor irregularity.

Results: The malocclusion status in a sample of the Free State patients seeking orthodontic treatment was recorded as 72.1% for Class I, 17.1% for Class II, and 10.8% for Class III subjects respectively. The occurrence of occlusal discrepancies was large overjet in 30.4%, deep overbite in 25.8%, anterior open bite in 9.2%, anterior crossbite in 61.4%, posterior crossbite in 27.4% and increased incisor irregularity in 75.7% of the total sample. 24.3% of the subjects required little or no treatment, 33.2% required moderate treatment, and 42.5% required great/severe treatment according to the modified DHC scores.

Conclusion: The need for orthodontic treatment in this sample is high and the prevalent occlusal characteristics are complex in nature. Treatment of these malocclusions will require qualified orthodontic specialists to carry out.

Keywords: Angle's Classification; Free State; Dental Health Component; Overjet; Overbite; Crossbite; Crowding; Occlusal Traits

Introduction

Planning orthodontic services within a public health system may require information on the prevalence and distribution of malocclusions [1]. Orthodontic services in the Free State province are offered mainly by the private sector and only to a very little extent by the government. Orthodontic services provided by the government of the Free State province are only offered in Pelonomi hospital, which is situated in Bloemfontein, the capital city of the province. Many orthodontic patients in the Free State province cannot afford private fees and as a result these patients are forced to seek alternative treatment from the government institutions. Unfortunately, due to limited resources, these patients are usually placed on very long waiting lists with an average waiting period of about 5 years with very little hope of ever receiving treatment. Because resources in government institutions can never be sufficient to meet the high demands of orthodontic treatment needs of the province, prioritization of these patients may be necessary in order to help with budget and resource allocation and also in ensuring that orthodontic services are preferentially provided to those patients who are most likely to derive the greatest benefit from them. Provision of interceptive orthodontic treatment by the general dentists may also be beneficial in order to reduce the burden of refer-

ral to the specialists. Thus, planning, provision and prioritization of orthodontic services may require some baseline epidemiological data with regards to the distribution of malocclusion and its severity within a given population, and this data is not available for the Free State province.

The World Health Organization recommends that health authorities must regularly conduct epidemiological surveys of the major oral conditions in different age groups. In the last survey of malocclusion conducted in South Africa, Booysen and Harris [2] conducted a study to estimate the prevalence of malocclusion amongst adolescents in the Upington area of the Northern Cape Province and to determine the need for orthodontic treatment using the Dental Health Component (DHC) of the Index of Treatment Need (IOTN) which was described by Brook and Shaw [3]. The results of this study showed that orthodontic treatment need exceeded 50%.

Materials and Method

The study population comprised of the orthodontic records of Black untreated subjects who were referred to the orthodontic clinic at Pelonomi tertiary hospital from 01 January 2012 to 31 December 2019. Ethical approval to conduct this study was obtained from the Biomedical Research Ethics Committee of the University of the Western Cape (Ethics Reference number: BM20/5/23, Appendix A). The study models were examined and graded by a specialist orthodontist in the department and any study model with broken teeth was not included in this study. The study analyzed the prevalence of malocclusion using Angle's method of classifying malocclusion and occlusal traits like overjet, overbite, anterior and posterior crossbites and incisor irregularity among the referred patients. These occlusal traits are measurable clinical characteristics which help to assess malocclusion and they were measured using the Dental Health Component (DHC) of the Index of Treatment Needs (IOTN).

The following variables were analyzed in the study:

- Angle classification was based on the sagittal relationship between the maxillary and mandibular first permanent molars. Subjects could fall into either class I, II or III groups.
- Overjet was measured horizontally in millimetres from the midpoint of the labial surface of the most anteriorly positioned maxillary incisor to that of the corresponding mandibular incisor parallel to the occlusal plane. Overjet was considered to be normal when it measured 1-3mm, large when it measured 4-6mm and excessive when it measured 7mm or more.
- Overbite was measured vertically in millimetres from the incisal edge of the maxillary incisor to that of the corresponding mandibular incisors. Overbite was normal when it measured 1-3mm, deep when it measured 4mm or more. Anterior openbite was diagnosed when there was lack of vertical overlap of the incisors and this was also measured in millimetres.
- Anterior crossbite was diagnosed when at least one tooth in the maxillary anterior area of the dental arch was biting lingual of the mandibular anterior teeth. It was recorded as either being present or not.
- Posterior crossbite was diagnosed when at least one tooth in the maxillary posterior area of the dental arch was biting lingual of the mandibular posterior teeth. It was recorded as either being present or not.
- Degree of treatment need was based on the severity of incisor crowding and this was measured using the modified Dental Health Component (DHC) of the IOTN [4]. The scoring involved measuring, in millimeters, the linear displacement of the anatomic contact points, as distinguished from the clinical contact points, of each maxillary and mandibular incisor from the adjacent tooth anatomic point. The sum of these five displacements represents the degree of incisor crowding for both jaws combined. Perfect alignment from the mesial aspect of the left canine to the mesial aspect of the right canine would have a score of zero, with increased crowding represented by greater displacement and, therefore, a higher DHC score will result. DHC scores of 1-3mm were considered to require little or no treatment, and scores of 4-6mm were considered to require moderate treatment, whereas scores of 7mm or more were considered to require severe need for treatment.

All statistical analyses were performed using the 16.0 version of Statistical Package for Social Sciences (SAS Institute Inc. Cary, NC). Descriptive statistics were calculated for the prevalence of malocclusion, occlusal characteristics and DHC grades.

Results

A total of 391 study models divided into 156 (39.9%) males and 235 (60.1%) females was used. Table 1 represents the percentage age distribution for the total sample broken according to gender. The age of the subjects ranged from 6 to 35 years with a mean age of 15.4 years. Among 391 subjects, 55 (14.1%) subjects were of age group 6-11 years, 240 (61.4%) subjects were of age group 12-17 years, 72 (18.3%) subjects were of age group 18-23 years, 20 (5.1%) subjects were of age group 24-29 years and 4 (1.1%) subjects were of age group 30-35 years of age. The highest number (61.4%) of patients was found in the 12-17 years age group, while the lowest number (1.1) of patients was found in the 30-35 years age group. Female subjects were more frequently represented in all the age groups for the total sample.

	N		
Age group	**Male**	**Female**	**Total**
6 - 11 years	23	32	55 (14.1%)
12 - 17 years	106	134	240 (61.4%)
18- 23 years	24	48	72 (18.3%)
24 - 29 years	3	17	20 (5.1%)
30 - 35 years	0	4	4 (1.1%)
Total	156 (39.9%)	235 (60.1%)	391 (100%)

Table 1: Percentage distribution of age for the total sample.

Table 2 represents the percentage distribution of Angle's malocclusion for the total sample broken according to gender. Female subjects were more frequently observed in all 3 classes of Angle's malocclusion. There were 282 (72.1%) subjects in Class I, 67 (17.1%) subjects in class II and 42 (10.8%) subjects in class III samples respectively.

Table 3 represents the percentage distribution of all the horizontal and vertical occlusal characteristics for the total sample broken according to age. Normal overjet was the most common horizontal occlusal characteristic recorded in 221 (56.5%) of the subjects. The highest number of subjects (135) with normal overjet was recorded in the 12-17 years age group and the lowest number of subjects (2) was recorded in the 30-35 years age group. Large overjet was recorded in 118 (30.2%) of the subjects with only one subject showing excessive overjet of more than 6mm and this was recorded in the 18-23 years age group. The highest number of subjects (78) with a large overjet was recorded in the 12-17 years age group and the lowest number of subjects (6) with a large overjet was recorded in the 24-29 years age group. No subject was found to have a large overjet in the 30-35 years age group. Reverse overjet was recorded in 51 (13%) of the subjects. The highest number of subjects (25) with reverse overjet was recorded in the 12-17 years age group and the lowest number of subjects (2) was recorded in the 30-35 years age group.

	N		
Angle class	**Male**	**Female**	**Total**
Class I	114	168	282 (72.1%)
Class II	27	40	67 (17.1%)
Class III	15	27	42 (10.8%)
Total	156 (39.9)	235 (60.1)	391(100%)

Table 2: Percentage distribution of Angle's classification of malocclusion for the total sample.

Overjet	**6-11**	**12-17**	**18-23**	**24-29**	**30-35**	**Total**	**%**
Reverse	10	25	8	3	2	51	13.0
Normal	26	135	48	10	2	221	56.5
Large	19	78	15	6	0	118	30.2
Excessive	0	0	1	0	0	1	0.3
Total	55	240	72	20	4	391	100
Overbite	**6-11**	**12-17**	**18-23**	**24-29**	**30-35**	**Total**	**%**
Anterior open bite	6	14	10	4	2	36	9.2
Edge-to-edge	1	9	1	1	0	12	3.1
Normal	39	152	143	6	2	242	61.9
Deep	9	65	18	9	0	101	25.8
Total	55	240	72	20	4	391	100

Table 3: Percentage distribution of overjet and overbite for the total sample.

Normal overbite was the most common vertical occlusal characteristic recorded in 242 (61.9%) of the subjects. The highest number of subjects (152) with normal overbite was recorded in the 12-17 years age group and the lowest number of subjects (2) was recorded in the 30-35 years age group. Deep overbite was the second most common vertical occlusal characteristic recorded in 101 (25.8%) of the subjects. The highest number of subjects (65) with deep overbite was recorded in the 12-17 years age group and the lowest number of subjects (9) with a deep overbite was recorded in the 6-11- and 24-29-years age groups. No subject in the 30-35 years age group was found to have a deep overbite. Anterior open-bite was the third most common vertical occlusal characteristic recorded in 36 (9.2%) of the subjects. The highest number of subjects (14) with anterior open bite was recorded in the 12-17 years age group and the lowest number of subjects (2) was recorded in the 30-35 years age group. Subjects exhibiting an edge-to edge relationship of the incisors were the least commonly recorded in only 12 (3.1%) of the subjects. The highest number of subjects (9) with edge-to-edge relationship of the incisors was recorded in the 12-17 years age group and the lowest number of subjects (1) with an edge-to-edge relationship of the incisors was recorded in the 6-11, 18-23 and also in the 24-29 years age groups. No subject in the 30-35 years age group was found to have an edge-to-edge relationship of the incisors.

Table 4 represents the percentage distribution of the anterior and posterior crossbites for the total sample broken according to age. Presence of the anterior crossbite was the most common finding recorded in 240 (61.4%) of the subjects. The highest number of subjects (150) with anterior crossbite was recorded in the 12-17 years age group and the lowest number of subjects (2) was recorded in the 30-35 years age group. Subjects without anterior crossbite were recorded in 151 (38.6%) of the total sample. The highest number of subjects (90) without anterior crossbite was recorded in the 12-17 years age group, while the lowest number of subjects (2) was recorded in the 30-35 years age group.

Posterior crossbite was not a common finding recorded in 106 (27.4%) of the subjects. The highest number of subjects (62) with posterior crossbite was recorded in the 12-17 years age group and the lowest number of subjects (2) was recorded in the 30-35 years age group. Subjects without posterior crossbite were recorded in 284 (72.6%) of the total sample. The highest number of subjects (178) without posterior crossbite was recorded in the 12-17 years age group, while the lowest number of subjects (2) was recorded in the 30-35 years age group.

Anterior crossbite	**6-11**	**12-17**	**18-23**	**24-29**	**30-35**	**Total**	**%**
Absent	21	90	28	10	2	151	38.6
Present	34	150	44	10	2	240	61.4
Total	55	240	72	20	4	391	100
Posterior crossbite	**6-11**	**12-17**	**18-23**	**24-29**	**30-35**	**Total**	**%**
Absent	40	178	51	13	2	284	72.6
Present	15	62	21	7	2	106	27.4
Total	55	240	72	20	4	391	100

Table 4: Percentage distribution of the anterior and posterior crossbite for the total sample.

Table 5 represents the percentage distribution of the degree of treatment need for the total sample broken according to gender. Among 391 patients examined; the distribution of the modified DHC scores was 95 (24.3%) for no/little treatment need, 130 (33.2%) for borderline treatment need, and 166 (42.5%) for great/severe treatment need. Female subjects were more frequently represented in all the treatment need groups for the total sample.

Discussion

In the present study, the total sample of 391 subjects with the age ranging from 6 years to 35 years with a mean age of 15.4 years was analysed. This age range represented the age distribution of patients who are referred to the orthodontic clinic at Pelonomi tertiary hospital. The mean age in this study is similar to that of other studies by Utomi and Onyeaso [5].

The results of the present study showed the prevalence of 72.1% for Class I, 17.1% for Class II and 10.8% for Class III malocclusion respectively (Table II). These findings will serve as reference data for the epidemiology of malocclusion in the Free State province. The prevalence of class I malocclusion in the present study is simi-

Gender	No/little Treatment needed	DHC grade Moderate treatment needed	Severe treatment needed	Total
Male	34	50	72	156
Female	61	80	94	235
Total	95 (24.3%)	130 (33.2%)	166 (42.5%)	391

Table 5: Percentage distribution of incisor irregularity broken according to gender.

lar to what was reported in Nigeria [6], however Mtaya, Brudvik and Angstrom [7] reported a much higher prevalence in Tanzania while Ismail., *et al*. [8] reported a lower prevalence in Malaysia.

The present study recorded a prevalence of 17.1% for Class II malocclusion. A higher prevalence of class II malocclusion has been reported in most Caucasian populations [9]. Foster and Walpole [10] reported a prevalence as high as 52.2% for class II malocclusion after analyzing a sample of English school children. In Latin America, the Middle East, and Asia there appears to be a lower prevalence of Class II malocclusion ranging from 10% to 15% [11-15]. Other studies conducted on Black populations of sub-Saharan Africa recorded even a lower prevalence of 1% to 10% for class II malocclusion [7]. The lowest prevalence of class II malocclusion ranging from 0-5% was reported in the Chinese population [16,17]. This phenomenon is clear on the continent of Australia where the majority population, primarily of European origin has Class II malocclusion prevalence similar to that of Europeans, whereas the native Aboriginal population has a prevalence of less than 1% [18].

The present study reported a prevalence of 10.8% for Class III malocclusion. Similar results were reported by Sandeep and Sonia [19] after evaluating a sample of school children in Rwanda. The prevalence of class III malocclusion has been reported to be very low in the Caucasian populations [9,20] and also in the Middle East [21] and India [22]. In Asian societies, it is appreciably higher, ranging from 4% to 13% [18,23]. In other African populations it ranges between 2% [7] and 8% [24].

In the present study, most subjects (56.5%) had a normal overjet in the range of 1-3mm (Table 3), while the prevalence of subjects with a large overjet of 4-6mm was recorded at 30.2%. This finding was also reported in another South African study [25] and Uganda [26]. These values are low when compared to those of Caucasian populations who recorded an even higher prevalence of up to 60.8% [27]. A small percentage (0.3%) of the sample in the present study displayed an excessive overjet greater than 6mm, and similar results were reported by Drummond [25] in another South African study. A higher prevalence of subjects with an excessive overjet was reported in Iran [28] and also in Uganda [26]. An excessive overjet may be associated with many dental health problems such as poor oral hygiene, gingivitis and periodontal diseases [29-31]. Dental trauma to the upper incisors, especially in the presence of incompetent lips is another significant risk associated with a large overjet [32,33]. A Cochrane review provided evidence that early treatment of children with a large overjet may be effective in decreasing the incidence of trauma to these teeth [34]. From the evidence of this study, it is clear that every effort should be made for the early referral of children presenting with a large overjet to help reduce the incidence of dental trauma as well as periodontal breakdown.

Some studies have recorded the degree of overbite as a fraction of the overlap of the incisors [12,13,15,35-37] while other studies measured the overbite in millimetres [14,38-44] and this makes the comparisons between different studies a very difficult exercise. An average of 25.8% of the subjects in the present study had a deep overbite of more than 3mm, and similar results were reported in Nigeria [6], Canada [9] and Australia [45]. A higher prevalence of deep overbite was reported in Uganda [26], Rwanda [19] and the United Kingdom [10], while a lower prevalence was reported in China [15] and South America [12]. A deep overbite is another malocclusion trait which must be treated when diagnosed as it is usually associated with soft tissue impingement which may predispose the patient to periodontal breakdown and ultimately tooth loss.

Anterior open bite was found to be the least prevalent malocclusion trait recorded at 9.2% of all the referred patients in the present study (Table 3). Similar results were reported by Ajayi and Ize-Lyamu in Nigeria [6] and Thilander and co-workers in Columbia [46]. In Africa, a higher prevalence of anterior open bite was reported in Rwanda [19] and also in Tanzania [7]. A higher prevalence of anterior open bite was also reported in South America [47] and also in Australia [45]. A lower prevalence of anterior open bite was reported in the Middle East [28] and also in China [15].

Anterior and posterior cross bites in the Free State subjects were recorded as 61.4%, and 27.4% respectively. This finding was also reported in another South African study of school children where the prevalence of anterior crossbite was reported to be higher in the late mixed dentition than the early permanent dentition stage (Drummond, 2003). A similar prevelence rate was reported by Albarakari and Sahartaher [48] who reported a prevalence of 60.5% of anterior crossbite after evaluating a sample of Saudi female subjects. Among the Italian 12 years-old children, 14.2% were reported to have the occurrence of anterior crossbites [49]. Ajayi and Ize-lyamu [6] recorded 21.4% anterior and 12.2% posterior cross bites in Nigerian subjects. A lower prevalence of anterior crossbite was reported in many parts of the world [28], with the lowest prevalence reported in South America [50].

Posterior crossbite was not a common finding recorded at 27.4%. This prevalence agrees with the statistics of other African studies [51] but is lower than the frequency of 10% reported by Ng'ang'a and co-workers [44]. Contrary to this however, Otuyemi and Abidoye [37] reported a prevalence of 1.4% of buccal crossbites and 0.3% of lingual crossbites in Nigeria. Al-Emran, Wisth and Böe [14] and Ng'ang'a and co-workers [44] found that buccal crossbites were twice more common than lingual crossbites (scissors bite). Where measurable, the premolars were the most frequent teeth found in crossbite on both the left and right sides similar to the findings of Cons, Mruthyunjaya and Pollard [39], who postulated that this could be the result of blocking out of the premolars due to premature loss of second primary molars.

In the present study, incisal crowding was also a very common characteristic of malocclusion, where both upper and lower arches were affected. Most of the referred patients in the current study presented with a severe form of incisor irregularity of more than 7mm in both arches. This pattern of presentation was also observed in another South African study [2] and in many Caucasian populations [27]. Incisal crowding is considered to be the most common malocclusion trait [52], and this is the most common reason for dissatisfaction with dento-facial appearance [53-55]. Crowded incisors have been associated with teasing and bullying with a subsequent low self-esteem among many children [56] and Trulsson and co-workers [57], and this is the main reason why the majority of patients seek orthodontic treatment [58].

Study implications

This study, the first of its kind in the Free State province has provided us with baseline data for the planning of orthodontic services using an objective method. Preliminary findings of this study were also presented at the International Association for Dental Research (IADR, South African Division), congress which was held in Pretoria in November 2020 (Appendix B). The results of this study will open doors to further research into the epidemiology of malocclusion, orthodontic treatment need and demand in the Free State province. Given the diverse cultural and ethnic groups found in the Free State Province, more research on the prevalence of malocclusion in these groups is warranted.

Conclusion

The need for orthodontic treatment in this sample is high and the prevalent occlusal characteristics are complex in nature. Treatment of these malocclusions will require qualified orthodontic specialists to carry out.

Conflict of Interests

The author declares no conflict of interest, and also that this study is not supported by any research grant.

Appendix A: Ethical Clearance Certificate.

Appendix B: IADR Acceptance Certificate.

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