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Editorial

Orthodontic Practice in the West-african Subregion: Maintaining the Standard of Care.

Orthodontic practice in the West African sub-region has gone through a lot of positive evolution, from the late twentieth century when there were very few Orthodontists practicing, till date when there are relatively more specialists involved in orthodontic practice in the sub-region. However, despite the relative increase in the number of orthodontists available, this number is still quite small, bearing in mind the huge population of the sub-region.

This increase in number of Orthodontists has also led to an increased awareness of orthodontics in the general population. Indeed, this is the case worldwide and not just in the sub-region as many more people are seeking orthodontic treatment, particularly adults.¹ In the West African sub-region, this increased demand for orthodontic care, coupled with the perceived profitability of orthodontic practice has led to an increase in the number of general practitioners providing orthodontic care. Indeed most members of the public are not able to differentiate between the general dental practitioner (GDP) and a specialist Orthodontist. This is very important bearing in mind the different levels of training received and different competencies of both groups, in the provision orthodontic care. Thus, while it is not illegal for a GDP to provide orthodontic care, it is important that they understand their limitations, as clearly stipulated by medical ethics, but sadly this is not always the case. This is worsened by the fact that some of the general practitioners actually practise as orthodontists, without clearly stating that they are general dental practitioners providing orthodontic care. According to the Medical and Dental Council of Nigeria, 'no medical or dental practitioner shall practice as a specialist, or pass himself off as a specialist, without having a specialist qualification which is registrable with the Medical and Dental Council of Nigeria'.²

Indeed, this occurrence is not limited to the West African sub region but has been observed worldwide This practice has also been facilitated by companies which claim to have designed newer orthodontic bracket systems, especially for general dental practitioners which they claim helps to 'accelerate orthodontic tooth movement' and 'shorten treatment time', with limited scientifically validated evidence to support this. This is often marketed to members of the public by general dental practitioners as a 'faster option' to conventional fixed appliance therapy.

Based on the above reports, it is important that Orthodontists practicing in the sub-region are able to distinguish themselves by the quality and standard of orthodontic care they provide. This should be reflective of the specialty training received which should distinguish the orthodontic care provided, from that received from a general dental practitioner. There is also a need for orthodontic associations in the sub-region, such as the Nigerian Association of Orthodontists, to continue to raise public awareness about orthodontics and the specialty in general. Indeed, it is important to emphasize that members of the public should seek the service of an Orthodontist, when requiring orthodontic care. Indeed, a lot has to be done in this regard to raise the awareness of the populace. Increased awareness will ensure that members of the public are able to seek appropriate specialist help when needed.

However, the reality is that the demand for orthodontic care is likely to outpace the supply of orthodontic specialists in the sub-region for some time to come. Thus, greater emphasis should be placed on training more specialist orthodontists, while general dental practitioners who are interested in providing orthodontic care, should be encouraged to receive further training in this regard. In the long run, as Orthodontists our primary concern should be to ensure that members of the public who seek orthodontic care get good quality care while also ensuring that the dignity of our specialty is preserved and protected.

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2. Medical and Dental Council of Nigeria (MDCN): Rules of professional conduct for medical & dental practitioners. <http://www.mdcnigeria.org/Downloads/CODE%20OF%20CONDUCTS.pdf>.

Dr I.G Isiekwe
Department of Child Dental Health,
Faculty of Dental Sciences,
College of Medicine, University of Lagos.



Experiences, Expectations, Attitudes and Perception of Orthodontic Residents Towards Orthodontic Training Programme in Nigeria

Adesina BA.^a, Adebayo ET.^b

Abstract

Background: The practice of orthodontics in Nigeria has witnessed gradual but steady development since its introduction over three decades ago. Despite significant increase in the number of orthodontic training institutions in Nigeria, there are relatively few orthodontists and even orthodontic residents in training for the population. This is to evaluate the experiences, expectations, attitudes and perception of Nigeria orthodontic residents towards their training.

Methods: This was a cross-sectional study conducted among Orthodontics residents at all the accredited Nigerian teaching hospitals. The instrument used was a self-administered, closed anonymous 46-items questionnaire. Data from the questionnaires were collated and entered into Microsoft Excel version 10, 2002 (Microsoft, Redmond, WA, USA) and processed using STATA software (StataCorp LLC, Texas, USA). Fischer's exact test was done where necessary. Statistical significance was set at $p \leq 0.05$ and tests were two-sided.

Results: Out of 41 orthodontic residents in 9 accredited training institutions in Nigeria, 34 participated in the study, representing 82.9%. Most residents (79.4%) chose orthodontics because of the quest for knowledge while a few (2.9%) were mentor guided. Majority (41.2% and 44.1 %) expressed low level of satisfaction with the quality of residency training and the didactic teaching in the program respectively.

Conclusion: The study concluded that most of the identified factors affecting orthodontics residency training program in Nigeria are trainee, trainer and curriculum related and will require the dental faculty of the postgraduate colleges to proffer solutions.

Key words: Professional experiences, Residency training, Attitudes, Expectations, Orthodontics, gender.

Author's Affiliation

^aDirectorate of Dental Services, Headquarters Nigerian Army Medical Corps, nbv

1 Victoria Island, Lagos, NIGERIA

^bDepartment of Oral and Maxillofacial Surgery, University of Medical Sciences, Laje Road, Ondo City, NIGERIA

Correspondence

Dr Adesina Bola, Nigerian Army Medical Corps Orthodontic Unit Bonny Camp, Lagos State Nigeria. Email: boladesina27@yahoo.com

Introduction

Orthodontia, also known as Orthodontics and Dentofacial Orthopedics, was the first specialty created in the meadow of dentistry¹. It is one of the foremost specialties in dentistry that is becoming more popular across the globe with increasing awareness in West Africa especially in Nigeria². Also, orthodontic practice in Nigeria has

witnessed a gradual but steady development since its introduction over three decades ago². Several studies have shown that most dental undergraduates intend to specialize later in their careers^{3,4}. Specialist training which is commonly acquired through the residency programme is not all together rosy⁵. Various reasons have been adduced as motivating factors in the choice of specialty. The most common reasons for Nigerian residents choosing orthodontics as a career are passion for orthodontics, intellectual stimulation and challenge, workload flexibility and predictability alongside future job satisfaction⁶.

Postgraduate orthodontic training in Nigeria and West Africa began over forty years ago with about nine accredited postgraduate orthodontic residency training institutions presently in the country⁷. predictability alongside future job satisfaction⁶. Postgraduate orthodontic training in Nigeria and

West Africa began over forty years ago with about nine accredited postgraduate orthodontic residency training institutions presently in the country⁷. Despite this significant number of orthodontic training institutions in Nigeria, the number of orthodontists remains low, so also orthodontic residents in training. A previous Nigerian study mentioned 'perceived phobia' for the residency programme by students and doctors alike with most resident doctors complaining that consultants contributed less than 50% to their training and other challenges including poor state of training facilities and low remuneration package⁸.

Nigeria with a population of over 200 million has only 55 orthodontists with 51 practicing in the country as at present. There are few studies on the challenges associated with orthodontics residency worldwide, hence the aim of this study was to evaluate the experiences, expectations, attitudes and perception of orthodontic residents towards their training. The specific objectives of the study were (1) to determine the demographics of orthodontic residents; (2) to assess their experiences, expectations, attitudes and perception towards residency training and (3) to evaluate the relationship between some socio-demographic characteristics to selected features of (2). Finally, the study was to recommend measures to improve orthodontic residency training in Nigeria. It is believed that the findings would contribute to the literature by outlining factors to improve the training of orthodontists in Nigeria and worldwide.

Materials and Methods

Study Design and Sample

This cross-sectional study was conducted among Orthodontics residents at all the accredited Nigerian teaching hospitals in 2017. The sample comprised all dental surgeons undergoing orthodontic residency training in the country. Questionnaires were distributed through a dental surgery resident (site coordinator) at the training institutions to encourage freedom of expression. Each site coordinator was briefed about the study especially about the study tool. The coordinator distributed the survey material and retrieved both blank and filled questionnaires at the end of the survey. These were sent back to the principal investigator. The questionnaire had an explanatory note on the rationale for the study and the confidentiality of the responses. Acceptance and completion of the questionnaire was taken as implied consent. The research protocol was approved by the Ministry of Defence Health Research Ethical Committee. A sample of the questionnaire has been published previously⁵.

Survey Instrument

The survey was conducted through a self-administered closed anonymous questionnaire adapted from Yeo et al⁹ for United States of America general survey residents. The questionnaire inquired about the technical, human and professional domains of the expectations, attitudes and perceptions of residents according to Herbella et al¹⁰. The adapted questionnaire had two parts. The first part had 10 questions on demographics while the 2nd part had 46 questions. The 2nd part was subjected to further discussions among orthodontic residents and their trainers (consultants) in 3 Nigerian teaching hospitals before it was finalized. The Cronbach's alpha for the 46-items was 0.751 which indicated they had good internal consistency (reliability).

The final 46-items questionnaire was tested on 70 dental residents; the data generated was subjected to principal factor analysis with a Varimax orthogonal rotation. An examination of the Kaiser-Meyer-Olkin measure of sampling adequacy showed that the sample was factorable (KMO=0.956). The first part of the questionnaire had 10 questions for demographic data such as training centre, age group, sex, marital status, specialty, number of years in residency training, last exam passed (yet to pass any exam-nil, passed primaries, passed part one and passed part two), sponsorship and main reason for choosing orthodontic residency training. Residents who are yet to pass part one, were classified as junior residents while the others were classified as senior residents. The 2nd part with 46 questions sought information on professional experiences, ethical issues, motivating factors, attitudes and opinion on the future of their specialty. The questions were structured as statements while the respondent indicated level of agreement using a 5-point Likert-type response scale, made up of strongly agree (5), agree (4), no opinion (3), disagree (2) and strongly disagree (1). for the 46-items was 0.751 which indicated they had good internal consistency (reliability). The final 46-items questionnaire was tested on 70 dental residents; the data generated was subjected to principal factor analysis with a Varimax orthogonal rotation.

An examination of the Kaiser-Meyer-Olkin measure of sampling adequacy showed that the sample was factorable (KMO=0.956). The first part of the questionnaire had 10 questions for demographic data such as training centre, age group, sex, marital status, specialty, number of years in residency training, last exam passed (yet to pass any exam-nil, passed

primaries, passed part one and passed part two), sponsorship and main reason for choosing orthodontic residency training. Residents who are yet to pass part one, were classified as junior residents while the others were classified as senior residents. The 2nd part with 46 questions sought information on professional experiences, ethical issues, motivating factors, attitudes and opinion on the future of their specialty. The questions were structured as statements while the respondent indicated level of agreement using a 5-point Likert-type response scale, made up of strongly agree (5), agree (4), no opinion (3), disagree (2) and strongly disagree (1).

Data Analysis

Data from the questionnaires were collated and entered into STATA software (Version 13; Stata Corp; College Station, TX, USA). The strongly agree/agree and disagree/strongly disagree responses were merged during data analysis. Categorical variables were calculated as proportions and percentages with 95% corresponding intervals. χ^2 -test was used to analyse the association between selected demographic characteristics and some of the responses. Fischer's exact test was done where necessary. Statistical significance was set at $p \leq 0.05$ and tests were two-sided.

Table 1a: Socio-demographic variables

Variable	Frequency	Percent
Age (years)		
25 – 29	4	11.8
30 – 34	15	44.1
35 – 39	9	26.5
≥ 40	6	17.6
Mean ± SD	34.50 ± 4.65	
Sex		
Male	15	44.1
Female	19	55.9
Marital status		
Single	7	20.6
Married	24	70.6
Divorced	1	2.9
Widowed	2	5.9
Number of children		
None	10	29.4
1 – 2	20	58.8
3 – 4	4	10.8

Results

Out of 41 orthodontic residents in 9 accredited training institutions in Nigeria, 34 participated in the study, representing 82.9%. The residents who did not participate were not available during the period of the study, but no available resident declined participation. This Organisations definition of a complete survey as that which is in line with the Council of American Survey Research with >80% items completed.

Table 1a summarizes the demographic variables of the respondents. Most respondents were females (n=19, 55.9%); aged between 30-34 years of age (n=24, 44.1%) and married (n=24, 70.6%).

Table 1b represents the duration, sponsorship characteristics and reason for residency. There were more junior residents yet to pass part One (n=17, 55.9%) while a few (n=5, 14.7%) had spent > 6 years in the residency program. Majority of the residents were university/teaching hospital staff (n=28, 82.4%), and a few were supernumeraries (n=5, 14.7%). Most residents (n=27, 79.4%) chose orthodontics because of the need for knowledge, n=2, 5.9% for better pay and n=1, 2.9% was mentor guided. The remaining (n=4, 11%) had orthodontics as the only available option.

Table 1b: Duration, sponsorship and reasons for residency

Variable	Frequency	Percent
Number of years		
< 1	11	32.4
1 – 3	7	20.6
4 – 6	11	32.4
> 6	5	14.6
Exams passed		
None	2	5.9
Primaries	17	50.0
Part 1	15	44.1
Sponsorship		
Self	1	2.9
University	28	82.4
Supernumerary	5	14.7
Reasons for residency		
Mentor guided	1	2.9
For knowledge	27	79.4
Better pay	2	5.9
No other option	4	11.8

Table 2 shows the experiences, expectations attitudes and perceptions of the study participants towards residency training. Majority expressed low level of satisfaction with the quality of residency training (n=14, 41.2%; 95% CI 28.1- 58.8) and even with the didactic teaching in the program (n=15, 44.1 %; 95% CI 28.1- 64.7). Greater number of orthodontic residents (n=18, 52.9%; 95% CI 32.4 – 68) believed the program had adequate support structures for struggling residents, thirty one (91.2%; 95% CI 82.4 – 100.0) claimed to have adequate support from departmental/faculty members while struggling in the program. Very few residents (n=2, 5.9%; 95% CI 0- 100.0) felt the residency program took too long to complete while some (n=15, 44.1%; 95% CI 82.4-100.0) agreed that the hours of working are causing a strain on family life. Also, few (n=2, 5.9%; 95% CI 0-14.7) were worried that orthodontics was going to become obsolete but most (n=31, 91.2%; 95% CI 82.4-98.3) agreed that post-residency specialist training was necessary. Specialist training for a dentist was considered a necessity for success by

most respondents (n=27, 79.4%; 95% CI 64.7 – 91.2) and 22(64.7%; 95% CI 48.7 – 80.7) agreed that expectation for good financial compensation informed their choice of orthodontics. Considering performance of tasks, majority of the residents felt their consultants/senior residents accommodate them if they ask for help when they don't know how to perform certain procedure (n=24, 70.6%; 95% CI 58.8-85.3) or manage a patient (n=24, 70.6%; 95% CI 55.9-86.6) while a few (n= 4, 11.8%; 95% CI 4.6 – 23.5) were worried that they would not have enough confidence to operate independently before the end of training. As regard stress and concern of residents, 24 (70.6%; 95% CI 54.6-83.6) were eager to come to work daily but about one fifth (n=7, 20.6%; 95% CI 8.8 – 35.3) had considered leaving the training program in the last one year. Most (n=33, 97.1%; 95% CI 88.2 - 100) really cared for their patients while 17(50%; 95% CI 34.0 – 67.6) were worried about hurting their patients.

Table 2: Experiences, expectations, and attitudes towards residency training

Variable	Agree	Neutral	Disagree
	n (95%CI)	n (95%CI)	n (95%CI)
Overall, I am very satisfied with the training program	13 (23.5 -51.3)	7 (11.8 -35.3)	14 (28.1 -58.8)
As a dental resident, my opinions are important	18 (34.0 -67.6)	12 (20.6 -52.9)	4 (2.9 - 24.8)
look forward to coming to work everyday	24 (54.6 -83.6)	6 (4.6 -2.4)	4 (2.9 -26.5)
I am satisfied with the didactic teaching in my program	12 (19.3 -50.0)	7 (8.8 -6.6)	15 (28.1 -64.7)
The program has support structures in place that provide me with someone to turn to when I am struggling	18 (32.4 -68.9)	5 (2.9 -9.4)	11 (16.4 -48.3)
I feel I can turn to members of the department/faculty when I have difficulties in the program	21 (42.8 -4.8)	7 (8.8 -6.6)	6 (4.6 -32.4)
Residency training is too long	16 (26.5 -1.8)	16 (32.4 -7.6)	2 (.0 -100.0)
The hours I am working are causing a strain on my family life	15 (28.1 -58.8)	7 (8.8 -32.4)	12 (17.6 -51.3)
I worry that my specialty is going to become obsolete	2 (.0 -14.7)	5 (4.6 -26.5)	27 (66.4 -92.5)
I will need to complete additional specialty training after I complete my residency training in order to be competitive in the job market	31 (82.4 -98.3)	2 (.0 -14.7)	1 (.0 -11.8)
- If I complete specialty training, I will have a better lifestyle	27 (64.7 -91.2)	5 (2.9 -6.5)	2 (.0 -16.0)

Variable	Agree	Neutral	Disagree
	n (95%CI)	n (95%CI)	n (95%CI)
Good financial compensation influenced my decision to be	22 (48.7 -80.7)	3 (.0 -18.9)	9 (13.4 -42.5)
My consultants will think worse of me if I ask for help when I do not know how to manage a patient	6 (7.5 -32.4)	4 (2.9 -3.5)	24 (55.9 -86.6)
-My consultant will think worse of me if I ask for help when I do not know how to do a procedure	6 (5.9 -29.4)	4 (.0 -23.5)	24 (58.8 -85.3)
I worry that I will not feel confident enough to perform procedures by myself before I finish training	4 (4.6 -23.5)	1 (.0 -8.8)	29 (73.5 -94.1)
-I have considered leaving my program in the last year	7 (8.8 -35.3)	6 (5.9 -32.4)	21 (44.5 -73.5)
I get a tremendous amount of satisfaction working with patients	20 (42.8 -77.7)	12 (19.3 -51.3)	2 (.0 -17.6)
I worry about hurting patients	17 (34.0 -67.6)	5 (2.9 -26.5)	12 (19.3 -54.2)

Tables 3a-c respectively analysed selected items for association with age groups, sex and exam passed. In Table 3a, orthodontic residents were placed into 2 age groups under categories < 35years and ≥ 35years. The level of satisfaction with residency training program was higher with residents with age less than 35yrs (42.1%) compared with those ≥ 35yrs (33.3%) but the difference was not statistically significant (p=0.631). Most of the younger age group

(89.5%) looked forward to come to work every day as against 46.7% of ≥ 35years group, the difference was very significant (p= 0.019). More (40%) of the older orthodontics residents (age group ≥ 35years) than the younger residents (5.3%) felt been disrespected by the consultants and trainers, this difference was also statistically significant (p=0.039).

Table 3a: Relationship between age and experiences, expectations, and attitudes towards residency training

Variable	Age (years)		χ^2	p value
	< 35 n (%)	≥ 35 n (%)		
Overall, I am very satisfied with the training program	8 (42.1)	5 (33.3)	0.273	0.601
As an orthodontic resident, my opinions are important	11 (57.9)	7 (46.7)	0.424	0.515
I look forward to coming to work everyday	17 (89.5)	7 (46.7)	5.48 ^Y	0.019*
I am satisfied with the didactic teaching in my program	7 (36.8)	5 (33.3)	0.045	0.832
I have considered leaving my program in the last year	2 (10.5)	5 (33.3)	1.454 ^Y	0.227
The hours I am working are causing a strain on my family life	7 (36.8)	8 (53.3)	0.925	0.336
I really care about my patients	19(100.0)	14 (93.3)	0.014 ^Y	0.905
I worry about hurting patients	8 (42.1)	9 (60.0)	1.074	0.300
The program has support structures in place that provide with someone to turn to when struggling	10 (52.6)	8 (53.3)	0.002	0.968
I do not feel respected by my consultants	1 (5.3)	6 (40.0)	4.244 ^Y	0.039*
Residency training is too long	8 (42.1)	8 (53.3)	0.424	0.515
I worry that I will not feel confident enough to perform procedures by myself before I finish training	2 (10.5)	2 (13.3)	0.081 ^Y	0.775
If I complete specialty training, I will have a better income	13 (64.8)	12 (80.0)	0.136 ^Y	0.712

Variable	Age (years)		χ^2	p value
	<35 n(%)	≥35 n(%)		
My consultant will think worse of me if I ask for help when I do not know how to do a procedure	4 (21.1)	2 (13.3)	0.018 ^Y	0.893
My consultants will think worse of me if I ask for help when I do not know how to manage a patient	3 (15.8)	3 (20.0)	0.018 ^Y	0.893
The modern specialist in my field must become specialty trained in order to be successful	12 (63.2)	10 (66.7)	0.045	0.832
Each year my expectations for the amount of money I am going to make when I finish training seem to go down	4 (21.1)	2 (13.3)	0.018 ^Y	0.893
One of the factors that influenced my decision to be an Orthodontist was the expectation of good financial compensation	14 (73.7)	8 (53.3)	1.520	0.218

χ^2 : Chi square test; Y: Yates corrected Chi square; *: p value <0.05

Other selected items analyzed by sex in table 3b had more females than male in agreement but the differences were not statistically

significant except that more males (73.3%) than females (36.8%) felt their opinions are important and also expressed satisfaction with the operative experience in the program with statistically significant difference (p=0.034) for both items.

Table 3b: Relationship between sex and experiences, expectations, and attitudes towards residency training

	Sex		χ^2	p value
	Male	Female		
Overall, I am very satisfied with the training program	7 (46.7)	6 (31.6)	0.808	0.369
As an orthodontic resident, my opinions are important	11 (73.3)	7 (36.8)	4.480	0.034*
I look forward to coming to work everyday	11 (73.3)	13 (68.4)	0.004 ^Y	0.949
I am satisfied with the didactic teaching in my program	6 (40.0)	6 (31.6)	0.260	0.610
I am satisfied with the operative experience in my program	11 (73.3)	7 (36.8)	4.480	0.034*
I have considered leaving my program in the last year	5 (33.3)	2 (10.5)	1.454 ^Y	0.227
The hours I am working are causing a strain on my family life	7 (46.7)	8 (42.1)	0.071	0.790
I really care about my patients	15 (100.0)	18 (94.7)	0.014 ^Y	0.905
I worry about hurting patients	9 (60.0)	8 (42.1)	1.074	0.300
The program has support structures in place that provide me with someone to turn to when I am struggling	6 (40.0)	12 (63.2)	1.804	0.179
I do not feel respected by my consultants	4 (26.7)	3 (15.8)	0.124 ^Y	0.724
Residency training is too long	8 (53.3)	8 (42.1)	0.424	0.515
If I complete specialty training, I will have a better income	12 (80.0)	13 (68.4)	0.136 ^Y	0.712
My consultant will think worse of me if I ask for help when I do not know how to do a procedure	2 (13.3)	4 (21.1)	0.018 ^Y	0.893
My consultants will think worse of me if I ask for help when I do not know how to manage a patient	2 (13.3)	4 (21.1)	0.018 ^Y	0.893
Each year my expectations for the amount of money I am going to make when I finish training seem to go down	3 (20.0)	3 (15.8)	0.018 ^Y	0.893
One of the factors that influenced my decision to be an Orthodontist was the expectation of good financial compensation	10 (66.7)	12 (63.2)	0.045	0.832
Orthodontists do not make as much money now as they used to	3 (20.0)	5 (26.30)	0.001 ^Y	0.974

χ^2 : Chi square test; Y: Yates corrected Chi square; *: p value <0.05

Table 3c was the analysis on the basis of last exam passed (nil, Primaries and Part One). It showed mixed responses to the selected items. The level of satisfaction with the training program was found to be higher among those yet to pass any of the fellowship examinations (50%) followed by those who had passed Part One (46.7%) and those who had passed Primaries examination (29.4%) but the differences were not statistically significant ($p=0.754$). However, those with primary were worried about performing poorly in front of senior residents and the difference

was statistically

significant (0.003). Junior residents below 2 years in the program were more worried (68.8%) than those who had stayed longer than 2 years ($p= 0.006$) as shown in table 3d. It was also discovered that more orthodontic residents who had spent between 3 – 6 years in the training program (53.8%) believed that orthodontists do not make money now as they used to as compare to those who had spent less than 3 years on the residency program. This difference was quite significant statistically ($p= 0.01$).

Table 3c: Association between exams passed and experiences, expectations, and attitudes towards residency training

Variable	Exams passed			χ^2	p value
	None n (%)	Primaries n (%)	Part 1 n (%)		
Overall, I am very satisfied with the training program	1(50.0)	5(29.4)	7(46.7)	0.563 ^Y	0.754
As an orthodontic resident, my opinions are important	0(0.0)	10(58.8)	8(53.3)	0.738 ^Y	0.691
I look forward to coming to work everyday	1(50.0)	13(76.5)	10(66.7)	0.092 ^Y	0.955
I am satisfied with the didactic teaching in my program	1(50.0)	7(41.2)	4(26.7)	0.341 ^Y	0.843
I have considered leaving my program in the last year	1(50.0)	4(23.5)	2(13.3)	0.165 ^Y	0.920
The hours I am working are causing a strain on my family life	2(100.0)	8(47.1)	5(33.3)	1.111 ^Y	0.573
The program has support structures in place that provide me with someone to turn to when I am struggling	1(50.0)	9(52.9)	8(53.3)	0.502 ^Y	0.778
I feel I can turn to members of the department/faculty when I have difficulties in the program	1(50.0)	12(70.6)	8(53.3)	0.563 ^Y	0.754
Residency training is too long	0(0.0)	7(41.2)	9(60.0)	1.005 ^Y	0.605
I worry that I will not feel confident enough to perform procedures by myself before I finish training	1(50.0)	3(17.6)	0(0.0)	1.506 ^Y	0.470
I worry about performing poorly in front of my senior residents	1(50.0)	12(70.6)	1(6.7)	11.153 ^Y	0.003
I worry about performing badly in front of my consultant	1(50.0)	13(76.5)	5(33.3)	4.690 ^Y	0.095
I worry that my specialty is going to become obsolete	0(0.0)	0(0.0)	2(13.3)	2.045 ^Y	0.359
Each year my expectations for the amount of money I am going to make when I finish training seem to go down	0(0.0)	2(11.8)	4(26.7)	0.509 ^Y	0.775
One of the factors that influenced my decision to be an Orthodontist was the expectation of good financial compensation	1(50.0)	10(58.8)	11(73.3)	0.341 ^Y	0.843

χ^2 : Chi square test; Y: Yates corrected Chi square; *: p value <0.05

Discussion

This study consisted of 34 orthodontic residents from the accredited postgraduate training institutions in Nigeria with the aim to evaluate their experiences, expectations and attitudes towards their training. Our study in table 1a showed there were female (55.9%) than males (44.1%), a ratio of 1.3:1 in the orthodontic residency program. This agrees with previous studies that underscored feminization of dentistry especially orthodontics.^{4,8,11}

A survey of gender distribution of dentists in Nigeria revealed that, over a twenty-year period, there has been a consistent rise in female dental practitioners from 15.3 percent in 1981 to 35.1 percent at the end of 2000¹². This is also corroborated by another Nigerian study that women in orthodontic training outnumbered men⁶. This increase in female participation should improve public perception of dentistry and orthodontics in particular. Most (70.6%) of the orthodontic residents were between the ages of 30–39 years which is in contrast to similar studies in the United state¹³ and Canada¹⁴ where majority of residents were between the ages of 25 to 34 years. However, it is similar to the earlier study of Nigerian dental residents⁵. This implied that Nigerians in orthodontics commence residency training at an older age compared to residents in the USA and Canada. Possible reasons such as commencement of undergraduate training at older ages, stay too long as undergraduates due to incessant strikes and other disruptions of academic work and prolonged interval before residency training due to paucity of slots.⁵ These may also explain why most of the participants (70.6%) were married. There is a need to improve on the undergraduate training calendar to reduce duration of stay while also assessing the causes and effects of entering residency training at an older age in Nigeria as well as its impact on quality of training and coping ability.

In an earlier Nigerian study, senior residents in orthodontics (61.5%), were more than junior residents (38.5%),⁷ our study in table 1b showed a different result (44.1 and 55.9% respectively). High proportion of senior residents could be indicative of stagnation after passing Part One examinations. Stagnation at the senior dental residency level was also reported by Adebayo et al,⁵ but our study found only 14.6% of orthodontics residents had stayed beyond the maximum 6years as compared to 44.5% in the earlier study⁵. It is advisable that trainees and trainers in other dental specialties evaluate the factors creating a disproportionate number of senior residents and those yet to pass Part Two examinations of the residency resulting in stagnation after passing Part One. Table 1b showed that most orthodontic residents (79.4%) chose the specialty because of the

quest for knowledge which was similar to the finding of Yemitan et al⁶. However, 'Enjoyment of providing care' in a specialty or field was identified as the single most important factor in choosing a specialty career in Harvard School of Dental Medicine¹⁴. A few (5%) expressed the opinion that expectation for good financial compensation informed their choice of orthodontics while 2.9% were mentor guided. This underscored the need for mentorship particularly during undergraduate training to help students make career decisions based on interest in the specialty and desire to gain more knowledge which could be more satisfying¹⁵.

Evaluation of experience, expectations, attitudes and perceptions of the orthodontic residents towards their training in table 2 showed that most respondents (41.2%) were dissatisfied with the quality of their training especially the aspect of didactic teaching. This contrasts with reports from other studies from the United States of America¹⁶ and Canada¹⁷. While 52.9% of orthodontic residents in Nigeria from table 2 agreed that they had appropriate level of operating skill from their training; a similar proportion (52.9%) agreed there was adequate support structures for struggling residents and 91.2% claimed to have adequate support from departmental/faculty members while struggling in the program. There is need to address the factors causing dissatisfaction of the orthodontic residents in Nigeria with their training. A few residents (5.9%) ; 95% CI 0- 100.0) felt that the residency program took too long to complete, while a good proportion (44.1%) agreed that the hours of working were causing a strain on family life. The training curriculum could be explored to make it 'family-life friendly'.

Table 3a showed that orthodontic residents of age category < 35yrs showed high level of satisfaction in their training program compared to those with age 35 and above though there was no significant difference. This may inform the reason why the younger age group in this study is always looking forward to come to work every day. However, larger percentage of age group ≥ 35yrs felt not being respected by their consultants than those younger than 35years (p= 0.039). Conduct and attitudinal behaviour of the trainers and trainees are to be considered in this regard. It could be that the relatively older trainees had more expectation for respect from their trainers or the trainers were not emotionally sensitive to the needs of this population of trainees.

Other selected items analyzed by sex had more

Table: 3d Association between number of years spent and experiences, expectations, as well as attitudes towards residency training

Variable	Number of years spent			χ^2	p value
	< 2 n (%)	3 – 6 n (%)	> 6 n (%)		
Overall, I am very satisfied with the training program	4(25.0)	8(61.5)	1(20.0)	6.784	0.128
I look forward to coming to work everyday	12(75.0)	10(76.9)	2(40.0)	4.233	0.322
I am satisfied with the didactic teaching in my program	6(37.5)	5(38.5)	1(20.0)	1.688	0.894
I have considered leaving my program in the last year	3(18.8)	3(23.1)	1(20.0)	6.891	0.104
The hours I am working are causing a strain on my family life	8(50.0)	6(46.2)	1(20.0)	4.379	0.357
I really care about my patients	15(93.8)	13(100.0)	5(100.0)	1.524	1.000
The program has support structures in place that provide me with someone to turn to when I am struggling	9(56.3)	7(53.8)	2(40.0)	4.077	0.397
I feel I can turn to members of the department/faculty when I have difficulties in the program	11(68.8)	9(69.2)	1(20.0)	5.505	0.200
I do not feel respected by my consultants	2(12.5)	3(23.1)	2(40.0)	3.070	0.569
Residency training is too long	7(43.8)	5(38.5)	4(80.0)	2.795	0.736
I worry that I will not feel confident enough to perform procedures by myself before I finish training	3(18.8)	1(7.7)	0(0.0)	2.994	0.551
My consultants will think worse of me if I ask for help when I do not know how to manage a patient	3(18.8)	1(7.7)	2(40.0)	2.847	0.621
I worry about performing poorly in front of my senior residents	11(68.8)	3(23.1)	0(0.0)	12.550	0.006
The modern specialist in my field must become specialty trained in order to be successful	10(62.5)	8(61.5)	4(80.0)	1.407	0.928
Each year my expectations for the amount of money I am going to make when I finish training seem to go down	2(12.5)	3(23.1)	1(20.0)	4.571	0.306
One of the factors that influenced my decision to be a surgeon was the expectation of good financial compensation	9(56.3)	10(76.9)	3(60.0)	3.142	0.583
Orthodontists do not make as much money now as they used to	1(6.3)	7(53.8)	0(0.0)	11.584	0.010

χ^2 : Chi square test; *: p value <0.05

Discussion

This study consisted of 34 orthodontic residents from the accredited postgraduate training institutions in Nigeria with the aim to evaluate their experiences, expectations and attitudes towards their training. Our study in table 1a showed there were female (55.9%) than males (44.1%), a ratio of 1.3:1 in the orthodontic residency program. This agrees with previous studies that underscored feminization of dentistry especially orthodontics.^{4,8,11}

A survey of gender distribution of dentists in

Nigeria revealed that, over a twenty-year period, there has been a consistent rise in female dental practitioners from 15.3 percent in 1981 to 35.1 percent at the end of 2000¹². This is also corroborated by another Nigerian study that women in orthodontic training outnumbered men⁶. This increase in female participation should improve public perception of dentistry and orthodontics in particular. Most (70.6%) of the orthodontic residents were between the ages of 30 – 39 years

females than male in agreement but the differences were not statistically significant except that more males (73.3%) than females (36.8%) felt their opinions are important and also expressed satisfaction with the operative experience in the program with statistically significant difference ($p=0.034$) for both items. This agrees with the finding among dental residents by Adebayo et al.,⁵ and it could be due to the influence of gender on responses by orthodontic residents.

There was mixed responses to selected items in table 3c on the basis of last exam passed by the respondents. The level of satisfaction with the training program was found to be 50%, 46.7%, 29.4% in among residents yet to pass any examinations, Primaries and Part One respectively though the differences were not statistically significant. Most junior residents (70.6%, $p=0.003$) especially those who had not spent more than 2 years in the program (68.8%, $P=0.006$) were worried of performing poorly in the presence of the senior residents. This could result to lack of confidence in clinical performances and even in the exams. There is the need to bridge the gaps between junior and the senior residents to create conducive learning atmosphere.

This study also revealed that orthodontic residents especially those who had spent between 3 – 6 years in the training program (53.8%) felt that orthodontists do not make money now as they used to compared to others ($p=0.010$). It revealed the change in perception of how lucrative orthodontics is as residents progress in the training program. There is also need for entrepreneurship training as part of the orthodontics residency to broaden financial horizons beyond looking for government employment so as to improve financial satisfaction after training.

Conclusion

Orthodontics is a foremost dental specialty that is becoming more popular across the globe with increasing awareness in West Africa especially in Nigeria. In this study, it was revealed that females are more in the residency training program compared to males and most of the orthodontic residents were between the ages of 30 – 39 years. The level of satisfaction with the training program was found to be higher than earlier reported among other dental surgery residents in Nigeria. Most orthodontic residents chose the specialty out of quest for more knowledge but some were worried that post-specialty practice may not be as financially rewarding as expected. Other dental specialist training

programmes could learn from the orthodontics specialty to improve satisfaction with training and reduce stagnation after residents have passed the Part One examinations. There is also need for the inclusion of entrepreneurship training in the curriculum of orthodontic residency to reduce reliance on government employment and embrace private practice for financial satisfaction.

Contributors

Adesina B.A was partly responsible for the study design, analysis and interpreting the data, writing and final approval of the study. Adebayo E.T was partly responsible for the concept, study design, acquisition of data and writing editing

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Conflict of Interest

None declared

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An Assessment of Awareness of Medical Doctors to Malocclusion and Orthodontic Services in a Nigerian Teaching Hospital.

Adeyemi T E^a, Otuyemi OD^b, Oguchi CO^c

Abstract

Background: The general health and well-being of individuals can be affected by the state of their oral health. Medical doctors may play an important role in early detection of orthodontic problems in critical areas including timely referral of malocclusion, thus preventing complications. This study assessed the level of awareness of medical doctors concerning malocclusion, orthodontic practitioners and orthodontic treatment services.

Methods: This cross-sectional study was conducted among 85 medical doctors in Aminu Kano Teaching Hospital, Kano (AKTH). Self-administered questionnaires were developed and distributed for data collection while statistical Software Package for Social Sciences (SPSS version 20) -Chicago was used for analysis. Statistical significance was set at $p < 0.05$.

Results: The sample population consisted of 83.5% male doctors and 16.5% female doctors with a mean age of 34.5 ± 6.4 years. Although, many of the doctors did not know that lip-sucking (61.2%) and thumb-sucking habit (48.2%) could adversely affect the front teeth alignment, most of them demonstrated good awareness concerning the orthodontic practitioners. Majority (69.4%) of the doctors were aware that orthodontic treatment services were being carried out in AKTH. Most male doctors did not know that the duration for orthodontic treatment was longer than most other dental procedures and this was statistically significant ($p = 0.025$).

Conclusion: Majority of the doctors were aware of availability of orthodontists personnel and orthodontic services in AKTH.

However, more male doctors had adequate knowledge of the features of malocclusion whereas their female counterparts were more informed about the duration of orthodontic treatment ($p < 0.05$).

Key words: Orthodontist; dentist; malocclusion; orthodontic treatment; medical doctors

Authors' Affiliations

^{a,c} Lecturer of Orthodontics, Department of Child Dental Health, Bayero University, Kano, Nigeria/ Aminu Kano Teaching Hospital.

^b Professor of Orthodontics, Department of Child Dental Health, Obafemi Awolowo University Teaching Hospital, Ile-Ife, Osun State, Nigeria.

Correspondence

Dr. Adeyemi Tope Emmanuel
Department of Child Dental Health,
Faculty of Dentistry,
Bayero University, Kano, Nigeria/ Aminu Kano Teaching Hospital.

Phone number: +2348060152099; e-mail address:
topmost007@yahoo.com

Introduction

The general health and well-being of individuals may be affected by the status of their oral health.¹ Malocclusion is one of the most common oral health problems of mankind along with dental caries, gingival disease, and dental fluorosis.^{2a} It can be referred to as an occlusion in which there is mal-relationship between the arches in any of the planes or there are anomalies in tooth position beyond the normal limits.

Malocclusion is often associated with health risks including poor oral hygiene, periodontal disease, temporo-mandibular joint disease, speech problems, mouth breathing and many more complications.^{2,4}

Generally, orthodontic problems (malocclusion traits) are associated with low mortality or morbidity; hence, they are overlooked by most health professionals as less important. Studies have shown that malocclusion can significantly impact on the psychosocial health of the affected person.^{5,6}

Prevention and interceptive treatment of oral diseases is expected to be effective if medical doctors who have more regular contact with individuals in developing countries are actively involved in screening and timely referral of patients with oral diseases especially malocclusion.⁷

Early detection of orthodontic problems, timely referral and prompt orthodontic treatment is of immense benefit in preventing the worsening of malocclusion complications.

Therefore, there is a need to assess the levels of awareness of medical doctors with respect to oral health and orthodontic treatment as they play an important role as primary care givers for most health-

oral health and orthodontic treatment as they play an important role as primary care givers for most health-related complaints in our healthcare sector. If medical doctors know the impact of malocclusion and orthodontics on the health and general well-being of their patients, they will be able to identify, educate, provide motivation and refer their patients for orthodontic assessment on time.⁸

There are few reported studies to assess the awareness of malocclusion, orthodontists and orthodontic treatment among medical doctors in Nigerian teaching hospitals.

This study assessed the level of awareness of medical doctors in Aminu Kano Teaching Hospital concerning malocclusion, orthodontic personnel and orthodontic treatment services.

Materials and Methods

Ethical approval to conduct this study was obtained from the Research Ethics Committee of Aminu Kano Teaching Hospital (AKTH), Kano state, Nigeria (NHREC/21/08/2008/AKTH/EC/2103) while informed consent was obtained from individual participants.

The study was a cross sectional survey conducted among a sample of 85 medical doctors with minimum degrees of Bachelor of Medicine; Bachelor of Surgery (MBBS holders) working in various departments of AKTH which is a major referral centre in north west Nigeria. AKTH is located in Kano Metropolis senatorial district, specifically in Tarauni local government area of the state.

All individuals who were non-MBBS holders were excluded from this study. MBBS holders who had received or were receiving orthodontic treatment were also excluded from this study.

Convenience sampling was used to recruit subjects in various departments that met the selection criteria.

Data was collected with the use of self-administered questionnaires and all the acquired data were processed and analyzed using statistical Software Package for Social Sciences (SPSS version 20) Chicago. Statistical significance was set at $p < 0.05$.

Results

The medical doctors consisted of 83.5% males and 16.5% females (Table 1) working in AKTH, Kano. The age of the participants ranged from 23 to 55 years with a mean of 34.5 ± 6.4 years. Their number of years of medical practice ranged from 0 to 29 years with a mean of 7.5 ± 5.5 years. Most (51.8%) of the participants were between 30 and 39 years old and they were mostly married (60.0%).

Table 2 shows that concerning the doctors' knowledge on malocclusion/irregular teeth, most

not know that thumb-sucking had an influence on the front teeth alignment. Concerning the section on awareness about dentist/orthodontist, most of the doctors demonstrated good awareness. However, with regards to knowledge on orthodontic treatment, majority (69.4%) of the doctors were aware that orthodontic treatment services were available and being carried out in AKTH while fewer medical doctors (52.9%) knew that few teeth may have to be removed for aligning/arranging irregular teeth.

Table 3 shows that more (79.4%) of the male doctors had noticed people having upper front teeth (incisors) stand out too far compared to their female counterparts (20.6%) and it was statistically significant ($P=0.041$).

Most of the male doctors (94.3%) compared to their female counterparts (5.7%) did not know that the duration for orthodontic treatment was longer than other dental procedures ($p=0.025$).

Figure 1 shows that concerning awareness about orthodontic treatment, majority (90.6%) of the doctors have heard about braces while only a few (17.6%) of them thought that braces were only for cosmetic purposes.

TABLE 1: socio-demographic characteristics of the participants

Characteristic	Frequency	%
Gender		
Male	71	83.5
Female	14	16.5
Total	85	100.0
Age groups		
20-29	27	31.8
30-39	44	51.8
40-49	12	14.1
50-59	2	2.3
Total	85	100.0
Marital status		
Single	34	40
Married	51	60
Total	85	100.0
Tribe		
Hausa/Fulani	46	54.1
Yoruba	7	8.2
Ibo	11	12.9
Others	21	24.7
Total	85	100.0
Religion		
Islam	61	71.8
Christianity	22	25.9
Others	2	2.3
Total	85	100.0

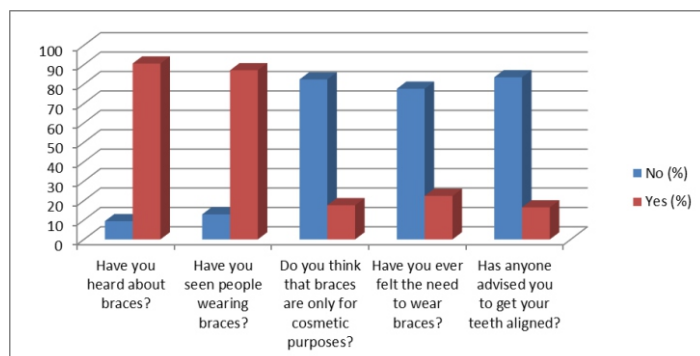
Table 2: Awareness and knowledge of medical doctors malocclusion and orthodontic services

	No: f (%)	Yes: f (%)
Have you heard of Malocclusion before?	22 (25.9)	63 (74.1)
Have you noticed people having irregular teeth?	2 (2.4)	83 (97.6)
Do you know crooked/irregular teeth have ill effects?	17 (20.0)	68 (80.0)
Are you aware that spaces between teeth are Abnormal?	31 (36.5)	54 (63.5)
Are you aware that crowded teeth are abnormal?	8 (9.4)	77 (90.6)
Do you think having upper front teeth (Incisors) bite behind the lower front teeth (Incisors) is abnormal?	29 (34.1)	56 (65.9)
Have you noticed people having upper front teeth (Incisors) stand out too far?	17 (20.0)	68 (80.0)
Have you noticed people having upper front teeth (Incisors) cover too much of the lower front teeth (Incisors)?	19 (22.4)	66 (77.6)
Do you believe teeth should be properly aligned/ arranged for a better facial appearance?	8 (9.4)	77 (90.6)
Does thumb-sucking have an effect on the front teeth alignment?	41 (48.2)	44 (51.8)
Does lip-sucking have an effect on the front teeth alignment?	52 (61.2)	33 (38.8)
AWARENESS ABOUT DENTIST/ ORTHODONTIST		
Are you aware of a dentist?	0 (0.0)	85 (100.0)
Have you visited a dentist before?	22 (25.9)	63 (74.1)
Have you heard of an Orthodontist?	12 (14.1)	73 (85.9)
Are you aware that orthodontists align/straighten teeth?	15 (17.6)	70 (82.4)
KNOWLEDGE ABOUT ORTHODONTIC TREATMENT		
Did you know taking braces treatment at an earlier age would improve facial appearance?	17 (20.0)	68 (80.0)
Do you know the duration for braces treatment is longer than other dental procedures?	35 (41.2)	50 (58.8)
Do you know that orthodontic treatment is costly?	29 (34.1)	56 (65.9)
Are you aware that few teeth may have to be removed for aligning/arranging irregular teeth?	40 (47.1)	45 (52.9)
Are you aware that Orthodontic treatment is done in AKTH?	26 (30.6)	59 (69.4)

Table 3: Relationship between gender and levels of awareness and knowledge of Medical doctors

Awareness and Knowledge of the respondents		Gender		Total: n(%)	X ²	
		Male: n(%)	Female: n(%)			
Have you heard of an orthodontist?	No	10(83.3)	2(16.7)	12(100.0)	0.000	0.984
	Yes	61(83.6)	12(16.4)	73(100.0)		
Have you heard of malocclusion before?	No	18(81.8)	4(18.2)	22(100.0)	0.063	0.802
	Yes	53(84.1)	10(15.9)	63(100.0)		
Have you noticed people having upper front teeth (incisors) stand out too far?	No	17(100.0)	0(0.0)	17(100.0)	4.190	0.041
	Yes	54(79.4)	14(20.6)	68(100.0)		
Do you know the duration for braces treatment is longer than other dental procedures?	No	33(94.3)	2(5.7)	35(100.0)	5.004	0.025
	Yes	38(76.0)	12(24.0)	50(100.0)		
Are you aware that orthodontic treatment is done in AKTH?	No	21(80.8)	5(19.2)	26(100.0)	0.207	0.649
	Yes	50(84.7)	9(15.3)	59(100.0)		

Figure 1: AWARENESS ABOUT BRACES TREATMENT



Discussion

The aim of this study was to assess the level of awareness of medical doctors in Aminu Kano Teaching Hospital concerning malocclusion, orthodontist and orthodontic treatment opportunities. Malocclusion is not a life threatening condition, however it has a lot of impact on the physical, emotional and psychosocial health of individuals affected.⁹

The gender distribution of the study participants shows that there were more male doctors than female doctors and majority were in the middle age group and married. This is consistent with the gender distribution within the Nigerian health sector which is still skewed in favour of men.¹⁰ This may be related to the cultural preference to educate male children over their female counterparts, thus leading to more male doctors than females in this study.

This study revealed that though majority of the doctors had heard about malocclusion, only few of them knew that lip-sucking and thumb-sucking had an effect on the front teeth alignment. This therefore justifies the need to enlighten medical doctors in the study population and generally concerning aetiological factors of malocclusion in order to ensure timely and appropriate referrals in the future.

Most of the doctors in this study exhibited excellent awareness about orthodontists as oral health providers. This high level of awareness may be due to the fact these doctors may have been practicing medicine for a long time, thereby increasing their chances of being familiar with orthodontists. The average number of years of practice of the doctors was 7.5 ± 5.5 years. The finding is in line with the reported increase in global awareness concerning

orthodontics as a dental specialty¹¹ and this is also consistent with other studies^{12,13} which reported that the levels of dental health knowledge are associated with the level of education and income. Medical doctors in a teaching hospital have either acquired or are in the process of acquiring advanced education and so they can be considered highly educated. This finding contradicts the poor awareness reported among medical students of King Khalid University, Abha, Saudi Arabia.⁸ This is likely due to the fact that participants in this study are medical doctors who obviously have more knowledge than medical students.

Our finding shows no significant difference in gender concerning knowledge of orthodontist and malocclusion as related to oral health. This is consistent with other studies.^{1,14} This may be due to the fact that both sexes had similar levels of education and were equally knowledgeable with regards to issues of oral health.

This study also showed that a good proportion of the doctors had heard about braces treatment, had seen people wearing braces and were aware that orthodontic treatment was being carried out in AKTH, thus making it easier for them to refer patients. Most of the participants did not think that orthodontic treatment was for cosmetic purposes.

The male doctors were more observant of features of malocclusion as they noticed people having upper front teeth (incisors) stand out too far compared to female doctors and this difference was statistically significant.

The female doctors were significantly more aware of the details of orthodontic treatment as most of them knew that the duration for orthodontic treatment was longer than other dental procedures. Female medical doctors seem to be more cautious and concerned about time spent in treatment than men.

Based on the results of present study, the authors would like to recommend for the inclusion of orthodontic topics in the continuous medical education (CMEs) programmes being organized from time to time for medical and dental practitioners who want to renew their annual practicing licenses in the country.

Some of the limitations of this study include the small sample size compared to the total number of doctors in the country which will make the results not

generalizable to all medical doctors in Nigeria; and the fact that this was a cross-sectional study with possible respondent bias.

The reported findings in this study will serve as a baseline for further studies on medical doctors concerning the subject in this environment.

Conclusion

This study shows that the awareness of doctors surveyed with regards to orthodontists and orthodontic generally is high

Male doctors were more knowledgeable about the features of malocclusion than females whereas more female doctors knew more about the duration of orthodontic treatment than their male counterparts.

Contributors

All authors contributed equally

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None declared

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Occlusal Characteristics of Orthodontic Patients Seen at a Tertiary Health Facility in Bamako, Mali.

Touré K.O.^a, Coulibaly B.^a, Kané A.S.T.^b, Ouédraogo Y.^c, Maïga A. S.^b, Pr Traoré H.^a, Pr Ngom P.I.^d

Abstract

Introduction: This study was carried out to study the orthodontic profile of patients receiving Orthodontic care at the University Hospital Center, National Center of Odonto-stomatology in Bamako, Mali.

Methods: This was a cross-sectional descriptive study. We evaluated the occlusion of patients receiving treatment at the University Hospital Center, National Center of Odonto-stomatology in Bamako. We observed the various orthodontic abnormalities in patients received at the Orthodontic department.

Results: The total study population comprised 432 patients, with 81% having Class I malocclusion, 6.9% in class II division 1, 4.2% in class II division 2 and 7.9% in class III. In addition, 53.7% with maxillary protrusion and 55.6% spacing. Dental abnormalities were in lower proportions (less than 7%).

Conclusion: Dento-alveolar disproportion in form of spacing, was the main anomaly observed in the population surveyed, whether or not associated with other anomalies. An epidemiological study is recommended to determine the prevalence of orthodontic malocclusions in the Malian population.

Key words: Malocclusions, orthodontic population, Bamako

Authors' Affiliations

University Hospital Center, National Center of Odonto-Stomatology,
Bamako- Mali

Dental Department of the Armed Forces of Mali, Bamako

University Hospital Center Yalgado Ouédraogo, Ouagadougou-
Burkina Faso

Department of Odonto-Stomatology, Cheikh Anta Diop University,
Dakar, Senegal

Correspondence

Touré K.O., University Hospital Center, National Center of
Odonto-Stomatology, Bamako- Mali

Introduction

Malocclusion is defined as an abnormality of teeth or inter-arch relationships deviating from normal. It is highly prevalent in populations and ranks third after tooth decay and periodontal disease¹.

Orthodontic malocclusion affects social, psychological and physical functioning, and its negative impact can therefore affect a person's quality of life by triggering physical and

psychosocial effects on the individual.

Consequently, the patient perceives orthodontics as a way to improve dentofacial aesthetics, in the hope of improving their social interactions, self-esteem, confidence and self-image¹⁻².

In Mali, demand for orthodontic treatment is now very popular despite its high cost, compared to the country's economic context. This treatment, which was initially and largely reserved for children and adolescents, has attracted more adults in recent years. The university hospital center and national center of Odonto-stomatology (CHU-CNOS) is the third reference structure which brings together various specialists including one orthodontist. The country has three qualified orthodontists for its nineteen (19) million citizens. This highlights the importance of early treatment and the involvement of general practitioners in order to avoid more complex orthodontic treatments.

Several studies have determined the prevalence of orthodontic malocclusions in different populations¹⁻⁸. As no official figure has yet reported orthodontic anomalies in Mali, it seemed appropriate

to us to collect data about the various malocclusions encountered in orthodontic consultation at our tertiary facility. Thus, the objectives of our study were to identify the main malocclusions seen in orthodontic consultation, determine the frequency of these malocclusions and to compare our data with those found in orthodontic and general populations around the world.

Materials and Methods

This was a descriptive, cross-sectional study based on the clinical records of patients who came for an orthodontic consultation at the CHU-CNOS from January to June 2018. The study population comprised of all patients received for an orthodontic consultation.

All clinical records of patients received for orthodontic consultation at the University Hospital Center, National Center of Odonto-stomatology from January to June 2018 were reviewed. Only the

records of patients of Malian nationality, who had not received previous orthodontic treatment and who had complete records including pre-treatment photographs, study models and panoramic radiographs.

The variables studied include socio-demographic details such as age, gender, occupation, ethnicity. A detailed orthodontic assessment was also carried out and the orthodontic variables assessed areas listed in the table 1 below and as described in Figs A1 to E3. Anteroposterior relationship was assessed with Angle's Classification, while other occlusal anomalies in the three planes of space were also assessed, in addition to dental anomalies such as supernumerary teeth, impacted teeth and missing teeth. (Table 1)

Statistical analysis was performed using SPSS software version 10.0. The chi square test was used to compare the frequency of abnormalities with gender.

Orthodontic variables analyzed	Study criteria
Spacing	Presence of space of more than 1 mm between the upper and lower incisors
Crowding	Presence of overlap of at least 1 tooth compared to the others
Supernumerary teeth	Presence of a supernumerary or additional tooth
Impacted teeth	Absence of a tooth on the arch and whose presence is confirmed in the jawbone by the orthopantomogram
Missing teeth	Absence of a tooth on the arch and whose absence is confirmed by the orthopantomogram
Angle class	According to Angle classification
Anterior open bite	End to end incisor or lack of incisor contact
Overbite	Upper coverage = 3 mm
Maxillary protrusion	Overjet greater or equal to 3 mm
Transverse direction	Presence of exoalveolus or endoalveolus



Figure 1: Normal occlusion

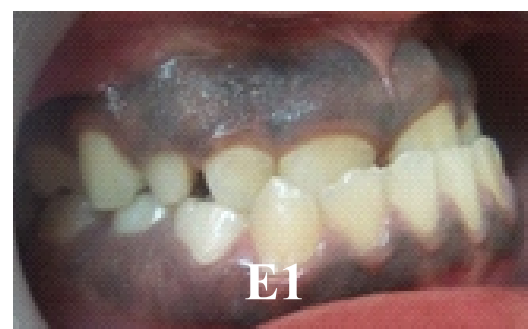
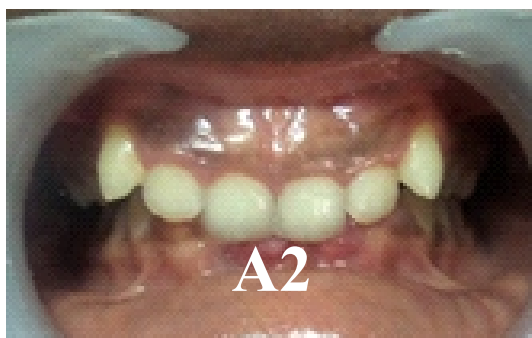
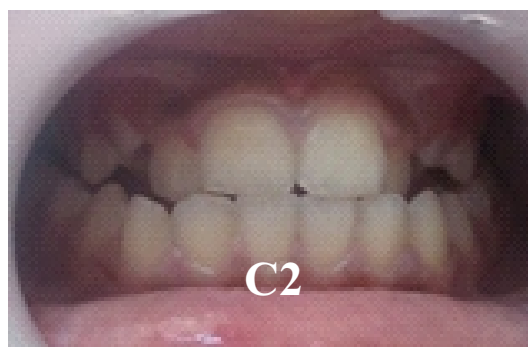
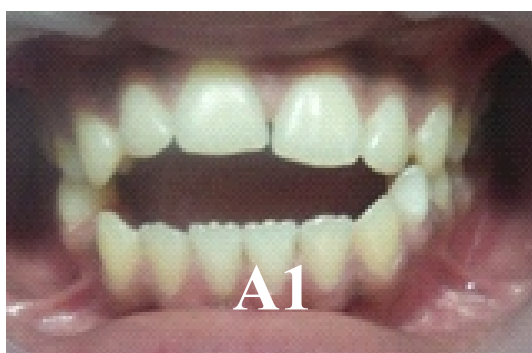
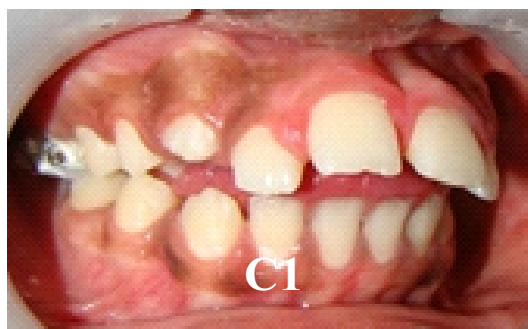




Figure 2: Different malocclusions

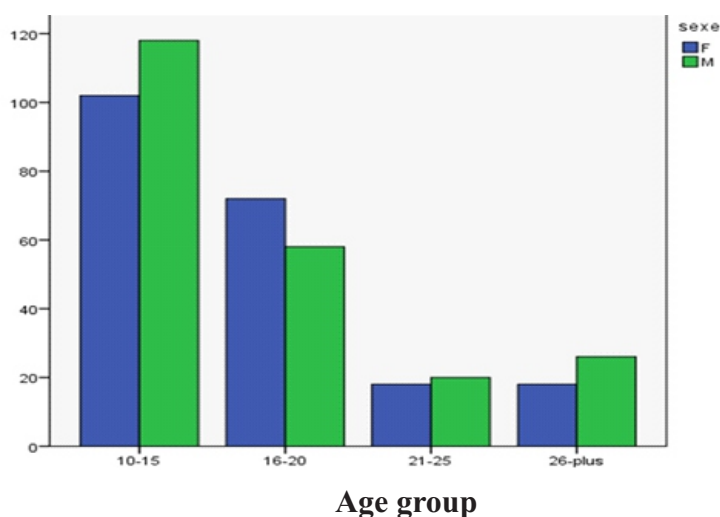
- A₁: Anterior openbite A₂: Deepbite
 B₁: Crowding B₂: Spacing
 C₁: Maxillary protrusion C₂: Maxillary retrognathism
 D₁: Supernumerary teeth D₂: Missing teeth
 E₁: Angle class III E₂: Angle class II

Results

Our sample was made up of four hundred thirty-two (432) subjects, comprising two hundred ten females (210, 48.6%) and two hundred twenty-two males (222, 51.4%).

In our population, 81% of our patients were in the 10-20 age group with more than 50% of the respondents in the 10-15 age group (Fig 3). Students made up 88.9% of our patients, against 6.5% of paid workers. The 432 patients were distributed among 10 ethnic groups with a predominance of Fulani people or Peulhs.

Figure 3: Distribution of the population by sex and age groups



The most frequent anomalies were dento-maxillary disharmonies due to dental defect (spacing) with 55.6%, followed by 53.7% of patients with maxillary protrusions. Crowding was observed in 33.6% of patients. Regarding dental anomalies, we observed 6.9% missing teeth and 0.5% supernumerary teeth. We found 14.4% anterior open bite and 6.9% overbite..

According to Angle's classification, 81% of our patients were in class I, 7.9% in class III, and 11.1% in class II (including 6.9% in class II division1 and 4.2% in class II division2).

Orthodontic anomalies	Total population			
	Total	Percent age	Female	Male
Spacing	240	55.6	124	116
Crowding	146	33.8	60	86
Impacted teeth	30	6.9	10	20
Missing teeth	30	6.9	16	14
Supernumerary teeth	2	0.5	2	0
Anterior openbite	62	14.4	34	28
Overbite	30	6.9	10	20
Transverse direction	46	10.6	16	30
Maxillary protrusion	232	53.7	118	114

Discussion

The lack of data in orthodontics in Mali prompted us to make this first observation on the main anomalies encountered in orthodontic consultation at the CHU-CNOS of Bamako. The data studied come exclusively from patients' medical records.

The study of our population showed an almost uniform proportion of both sexes, 48.6% of women and 51.4% of men. We note a predominance of the male sex at the level of all age groups except in the 16-20 group where the female sex is predominant. This can be explained by the strong aesthetic demand among young women of this age group.

Thermac³ found a similar result with an almost equal distribution between the two genders (47% girls, 53% boys) in an orthodontic population of Lyon. In their study, after 16 years, we find more women, which can be explained by an aesthetic demand and a

a higher awareness among women. Diop-Ba et al.,² found 59% girls and 41% boys in a similar study carried out in Senegal.

In terms of ethnic origin, Thermac,³ found a predominance of the North African (42%), Caucasian (34.3%), and African (17.3%) populations, well in agreement with the diversity of the French population. In our study, we found a majority of Fulani who nevertheless represent the second ethnic group in Mali in terms of representativeness in the population.

The most frequent abnormality in our study was dento-maxillary disharmony with the presence of diastemas (spacing) in 55.6% of our patients. Aka et al.,⁴ found the same result in an orthodontic population in Abidjan with 48% diastemas. Onyeaso,⁵ found 37% diastemas in adolescents in Ibadan, Nigeria. These diastemas are quite frequent in black populations and sometimes are a sign of beauty in certain ethnic groups in Mali.

We found 33.8% crowding. This result is close to that of Celestin,⁶ in Côte d'Ivoire who found 40.5% tooth-arch disharmony in an orthodontic population, and that of Aka,⁴ with 41% crowding. daCosta and Utomi,⁷ found up to 43.2% mandibular crowding in a Nigerian population.

Maxillary protrusion was found in 53.7% of patients. This figure is much higher than the 20.7% observed by Celestin⁷. In Morocco, Bourzgui et al.,⁸ reported a prevalence of 27.2% of overjet greater than 4 mm in schoolchildren aged 8 to 12 years. Ouedraogo et al.,⁹ found 22.8% of exaggerated positive overjet thus making this anomaly the most frequent in their study. This disparity between the figures could be explained on the one hand by the ethnicity and the criteria used to define the variables. On the other hand, the aesthetic impairment linked to this anomaly could explain its higher prevalence in orthodontic consultation in our study.

Our study found 81% of subjects in class I, 6.9% in class II division 1, 4.2% in class II division 2 and 7.9% in class III. Our figures are consistent with those found by Sonan et al.,¹⁰ in a school population in the Abidjan region. Ousehal et al., found 52.90% of class I. Uslu et al.,¹¹ in Turkey and a Nigerian study,⁷ found a predominance of class I among their patients received for orthodontic consultation. In Senegal Diop-Ba² found 41.28% class I, 34.86% class II and 14.68% class III. These values show that class I has a higher frequency in general, although this observation is contrary to that of Thermac et al.,³ who found only 23% of patients in class I and 69% in Class II.

Our study found 14.4% anterior open bite and 6.9% with deep overbite in population surveyed.. These figures are comparable with those of daCosta and Utomi⁷ and Thermac³, respectively with values of 11.2% and 14% of anterior open bite. Oneyaso⁵ reported 5.2% anterior open bite and 3.8% deep bite in a Nigerian population. In Senegal, Diop-Ba et al.,² found 34.26% anterior open bite and 25.93% overbite. These values are significantly higher than our figures.

The low rates of supernumerary teeth (0.5%) and agenesis (6.9%) are also found in Turkey and Brazil in orthodontic populations¹¹⁻¹². There were no significant gender differences observed in our study in the occlusal traits and abnormalities studied. The disparities observed between our values and those of other populations through this study could be explained on the one hand by ethnic origins, the age of the patients and on the other hand by the method of data collection.

Conclusion

It emerges from this observation that dento-alveolar disproportion in form of spacing, was the main anomaly observed in the population surveyed, whether or not associated with other anomalies. We also noted that class I was the most common of the Angle classes observed in the study population. Dental abnormalities had a relatively low frequency. This study carried out in an orthodontic population does not reflect the real prevalence of orthodontic malocclusions in the Malian population.

An assessment should therefore be carried out in a well-targeted population to compare with other populations in order to identify the real treatment needs in our country.

Contributors

All authors contributed equally

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Conflict of Interest

None declared

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Frequency and Pattern of Orthodontic Extractions: A 5 Year Review.

daCosta OO^a, Umeh OD^b, Obilade O^c

Abstract

Background: Orthodontic tooth extraction is defined as the removal of one or more permanent teeth excluding the third molars in the course of corrective orthodontics. The frequency of extraction has changed over the years with the evolution of new treatment mechanics.

Aim: To determine the frequency and pattern of orthodontic extraction among orthodontic patients.

Methods: This was a retrospective descriptive study and the study sample comprised of 237 patients who had undergone or were undergoing orthodontic treatment in the Orthodontic Clinic of the Lagos University Teaching Hospital Idi-Araba Lagos Nigeria over a 5 year period. All relevant information required was obtained from the case file of these patients. Basic descriptive statistics, Chi-Square and Student's t-test were used for data analysis. Level of significance was set at $P < 0.05$.

Results

A total of 237 orthodontic patients were recruited for the study; 78 males and 159 females. Angle's Class I malocclusion was the predominant molar relationship. An extraction prevalence of 53.2% was observed with a total of 340 permanent and 44 primary teeth extracted. The upper first premolar was the most frequently extracted tooth, accounting for 72.9% of all permanent teeth extracted (248 teeth), while the primary canine was the most frequently extracted primary tooth. The most common extraction pattern observed in this study was the extraction of all first premolars (28.6%), followed by the extraction of upper first premolars (16.7%). There was no statistically significant difference in the extraction prevalence between males and females ($P = 0.5$).

Conclusion: There was high extraction prevalence in the current study when compared to the Caucasian studies, with the first premolars being the most frequently extracted tooth.

Key words: Extractions; Orthodontics; Malocclusion.

Authors' Affiliations

daCosta Oluranti O^a, Umeh Onyinye D^b, Obilade O^c

^aProfessor/ Consultant, College of Medicine University of Lagos/Department of Child Dental Health, Lagos University Teaching Hospital, Lagos Nigeria.

+2348023221208, e-mail- rantidacosta@gmail.com

^bLecturer/ Consultant, College of Medicine University of Lagos/ Department of Child Dental Health, Lagos University Teaching Hospital, Lagos Nigeria.

+2348081412492, e-mail- umehod@gmail.com

^cLagos University Teaching Hospital, Lagos Nigeria

e-mail- lalaladejobi@yahoo.com

Correspondence

Umeh Onyinye Dorothy. Department of Child Dental Health, Lagos

University Teaching Hospital Idi-Araba, Lagos. +2348081412492,

e-mail- umehod@gmail.com

Introduction

In the management of malocclusion, clinicians are required to make sound orthodontic diagnosis and develop a treatment plan. This often requires several intricate decisions as the clinician makes a choice whether or not extraction will be required to achieve the treatment objective.¹ Tooth extraction in Orthodontics is surrounded by a number of controversies as different orthodontists argue for and

against it.^{1,2} Orthodontic tooth extraction is defined as the removal of one or more permanent teeth excluding the third molars in the course of corrective orthodontics.^{1,3}

The frequency of extraction has varied over the years reaching a peak in the early 19th century where teeth were extracted mainly to relieve crowding.^{3,4} Over time, the introduction of newer techniques and systems such as the use of functional appliances, bonded rather than banded appliance, self-ligating systems, and interproximal stripping as well as arch expanders have played significant roles in the dynamic changes observed in extraction frequency among orthodontic patients.^{2,4}

An important factor which comes to the fore in extraction decisions among others include the morphological features of malocclusion.² As observed with morphologic features, genetic differences should count for variations among different subjects; with ethnicity playing a significant role in morphologic disparity.⁵ Therefore, with respect to craniofacial morphology, different racial and ethnic groups should not be considered to

be the same.⁶⁻¹⁴ Although not much is reported on the association between race and treatment in orthodontic literature,² identifying obvious racial differences are the increased SNA, SNB and ANB cephalometric angles¹⁵ in the Nigerian population as well as greater dental and lip protrusion¹⁶⁻¹⁸ in African populations will affect treatment objectives and plan. Existing literature have considered extraction frequencies and pattern among different orthodontic populations with varied findings^{1-4,19-23} with an obvious data paucity in an African population. It would be noteworthy therefore to assess the prevalence and pattern of orthodontic extractions in Nigeria and verify if the results compare with findings from previous non African studies.

Orthodontic extractions have been reported to be the second most common cause of extraction in a national survey of Nigerian children accounting for 22.8% of all teeth extracted.²⁴ A similar survey by Adeyemo et al.²⁵ implicated orthodontic treatment as the third most common cause of tooth loss after caries and periodontal disease and accounted for 2.8% of all teeth extracted. The pattern of teeth extractions was however not reported.

The purpose of this study therefore was to determine the frequency and pattern of extraction among orthodontic patients in Nigeria, and how it compares with the pattern in previous studies from other populations.

Materials and Methods

Ethical approval was granted by the Health Research and Ethical Committee, Lagos University Teaching Hospital Idi-Araba, Lagos for use of clinical information from the Orthodontic clinical records before commencement of the study. The study population comprised 237 orthodontic patients who had undergone or were undergoing orthodontic treatment in the Orthodontic Clinic over a 5 period (2009-2013). The information required were obtained from the patients' case file and entered into an information sheet. Information obtained included patients' bio data (age at presentation, sex and nationality) and malocclusion pattern. Also recorded were patients' Angle's molar classifications, tooth size-arch length discrepancy; assessing the presence or absence of spacing and crowding in the dental arches,

and overbite (the vertical relationship between the upper and lower incisors). Information on the need for extractions during orthodontic treatment, prevalence, tooth type and pattern of tooth extraction were also obtained. Inclusion criteria were all patients who started their orthodontic treatment in the Orthodontic clinic of the Lagos University Teaching Hospital and of were of Nigerian ancestry. Subjects with Congenital anomalies e.g. Cleft lip and/or palate, special needs patients and transfer patients who started their treatments from other health institutions were excluded from the study.

Data was analysed using Epi.InfoTM for windows (version 3.5.1) statistical software. Descriptive statistics was used for the subjects' demographics. The results were presented in figures, charts and frequency tables. Students t-test was used to assess the significance of the difference between means of 2 sets of data and Chi square test of independence and Fischer's P-exact statistics were used determine the association between categorical variables. The level of significance was set at $P < 0.05$ for all statistical analysis.

Results

The subjects' age at the start of treatment ranged from 7-30 years with mean ages of 15.3 ± 6.9 years and 18.1 ± 8.1 years in the male and female subjects respectively. A total mean age of 17.2 ± 7.9 was observed with approximately 50% of the study population in the 10-19 years age limit. The males were observed to be significantly younger than the female ($p = 0.01$) (Table 1).

An assessment of the Angle's molar relationship of the study subjects showed Angle's Class I malocclusion as the most common and observed in 74.3% of the study participants, followed by Angle's class II div I malocclusion (15.2%). Other molar relationships were observed however uncommon (Figure 1).

Evaluating the tooth size -arch length discrepancy among study subjects, 30% and 42.6% had well aligned anterior segments in the upper and lower arches respectively. Spacing malocclusion was more prevalent than crowding and observed to be more common in the upper segment, while crowding was more predominant in the lower arch; observed in 31.7% of the study subjects. A majority of the

patients however had well aligned posterior segments (upper-96.2%, lower-98.7%).

The prevalence of orthodontic extraction observed in this study was 53.2%. A total of 340 permanent and 44 primary teeth were extracted with the upper first premolar being by far the most frequently extracted permanent tooth, and accounting for 248 (72.9%) of all extracted teeth (Table 2). This was followed by the second premolars (21.5%) and supernumerary teeth (2.6%). Less frequently extracted were the central and lateral incisors and the second molars (0.3%). No permanent canine extractions were reported.

Forty-four primary teeth were extracted in the study. The primary canine was the most common primary tooth extracted and accounted for 7% of all teeth extracted and 64% of extracted primary teeth. The extraction of primary incisors and molars was observed to be uncommon (Table 3)

Evaluating the pattern of extractions between sexes and the dental arches, it was observed that tooth extractions were more prevalent in the males (56.4%) compared to the females (53.2%), although statistically insignificant ($P=0.48$), and for all tooth types. Extraction frequencies were observed more in

the maxilla than the mandible, except for the permanent lateral incisor, first and second molars, which were more frequently extracted in the mandible. The first premolar was observed to be the most frequently extracted tooth, followed by the second premolar in both maxillary and mandibular arches. The difference in extraction frequency in the maxilla and mandible was statistically insignificant ($P=0.286$) (Table 3).

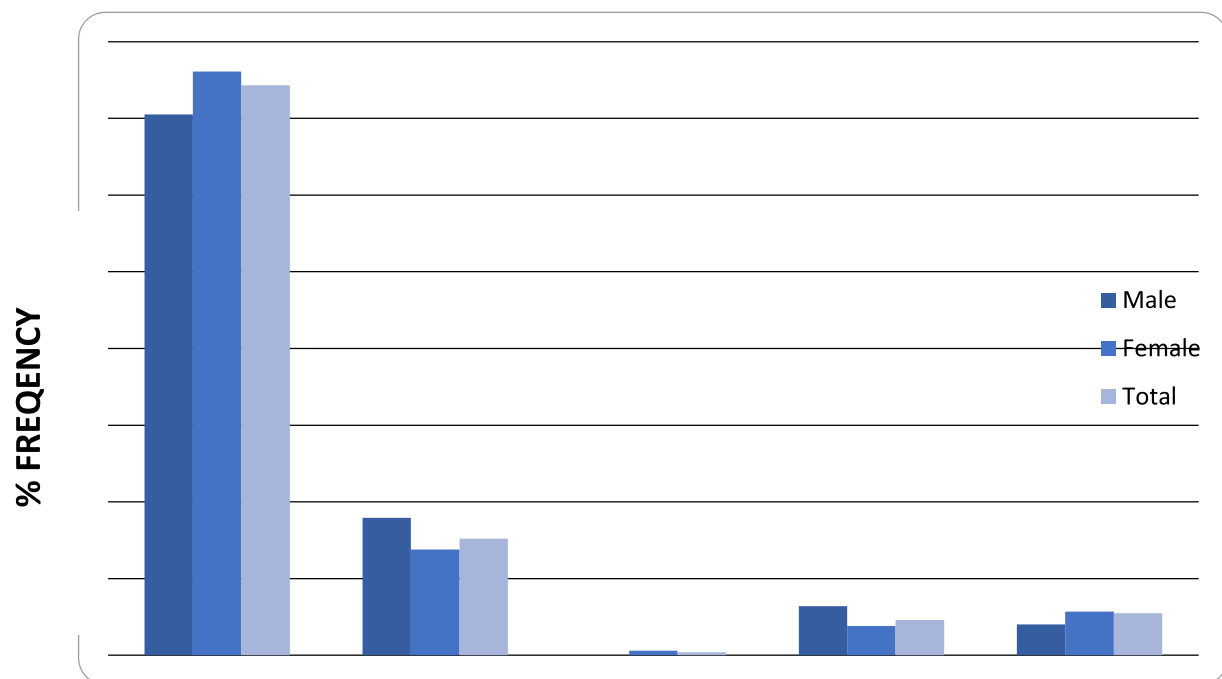
The 4-unit extraction of all first premolars was the most common extraction pattern and comprised 29% of all extractions. This was followed by the extractions of upper first premolars and retained primary teeth in 16.9% and 11.3% of subjects respectively. The extraction of other teeth such as supernumerary teeth, incisors and first molars collectively accounted for 21% of the extractions. Extraction patterns of the upper first and lower second premolars, all second premolars, upper 2nd premolars and lower 1st premolars, lower first premolars only and upper 2nd premolars were infrequently carried out in the management of the study subjects (Table 4, Figure 2).

Table 1: Age distribution study participants

Age (year)	Frequency (%)		
	Male (n=78)	Female (n=159)	Total
< 10	12(15.4)	22 (13.8)	34(14.3)
10-19	46 (59.0)	70(44.0)	116(48.9)
20-29	15 (19.2)	56(35.2)	71(30.0)
30	5(6.4)	11(6.9)	16 (6.8)
Total	78 (100)	159(100)	237(100)
Mean age	15.3±6.9	18.1±8.1	17.2±7.9

Student's t statistic =2.59=0.01*

***Significant**

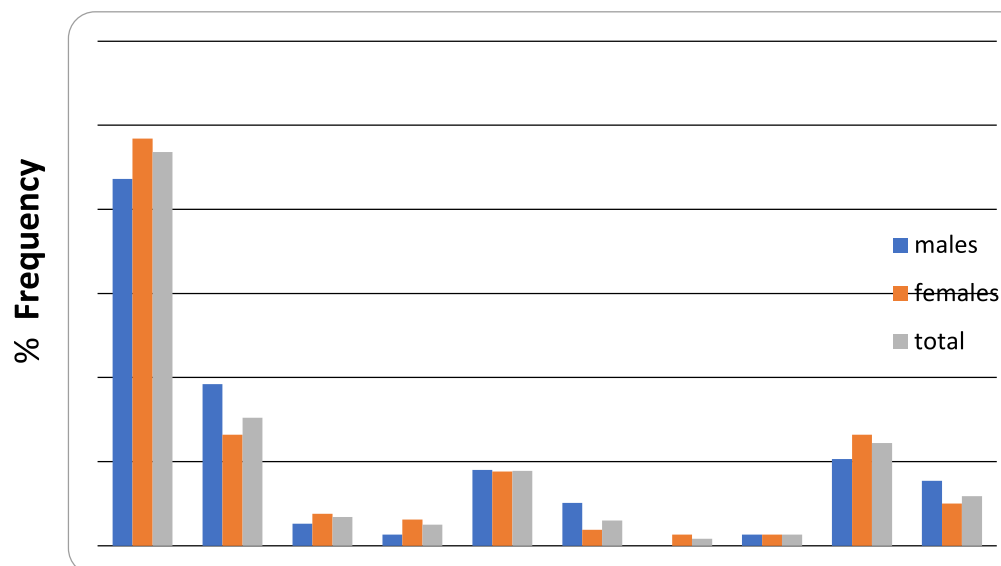


ANGLE'S CLASSIFICATION OF STUDY POPULATION

Figure 1: Angle's molar relationship of study participants

Table 2: Tooth Extraction Frequency by Tooth Type

TOOTH TYPE	FREQUENCY %					
	Female		Male		Total	
	Frequency	%	Frequency	%	Frequency	%
Central Incisors	1	0.5	0	0.0	1	0.3
Lateral Incisors	0	0.0	1	0.8	1	0.3
Canines	0	0.0	0	0.0	0	0.0
First Premolars	151	71.2	97	75.8	248	72.9
Second Premolars	52	24.5	21	16.4	73	21.5
First Molars	6	2.8	1	0.8	7	2.1
Second Premolars	0	0.0	1	0.8	1	0.3
Supernumeraries	2	0.9	7	5.4	9	2.6
TOTAL	212	100.0	128	100	340	100.0



Extraction pattern of study population

FIG 2: Extraction pattern in the study population

Table 3: Distribution of Teeth Extracted

MAXILLA	FEMALE		MALE		TOTAL	
	NO.	%	NO.		NO.	
Central incisor	1	0.4	0	0.0	1	0.3
Lateral incisor	0	0.0	0	0.0	0	0.0
Canine	0	0.0	0	0.0	0	0.0
First premolar	89	35.7	55	27 40.1	144	37.3
Second premolar	27	10.8	11	8.0	38	10.0
First Molar	3	1.2	0	0.0	3	0.8
Second Molar	0	0.0	0	0.0	0	0.0
Supernumerary	2	0.4	6	4.4	8	1.8
MANDIBLE						
Central incisor	0	0.0	0	0.0	0	0.0
Lateral incisor	0	0.0	1	0.7	1	0.3
Canine	0	0.0	0	0.0	0	0.0
First premolar	62	24.9	42	30.7	104	26.9
Second premolar	25	10.0	10	7.3	35	9.1

Table 3: Distribution of Teeth Extracted

First Molar	1.2	0.7	1.0			
Second Molar	0.0	0.7	0.3			
Supernumerary	0.4	0.7	0.5			
DECIDUOUS						
MAXILLA						
Central incisor	0.8	0.0	0.5			
Lateral incisor	0.8	0.0	0.5			
Canine	5.6	3.6	19	4.9		
First molar	2.0	0.0	1.3			
Second molar	0.8	0.0	0.5			
MANDIBLE						
Central incisor	0.4	0.0	0.3			
Lateral incisor	0.4	0.0	0.3			
Canine	2.0		2.1			
First molar	1.6	0.0	1.0			
Second molar	0.0	0.0	0.0			
TOTAL	249	100.0	137	100.0	386	100.0

Table 4: Tooth extraction pattern and additional extraction according to sex

Variable	Male n = 78		Female n = 159		Total n = 237			
	Freq .	%	Freq .	%	Freq .	%		
Tooth extraction								
Nil	34	43.6	77	48.4	111	46.8	0.49	0.48
Retained Deciduous	6	7.7	8	5.0	14	5.9	0.67	0.40
Others	8	10.3	21	13.2	29	12.2	0.42	0.52
All 4s	15	19.2	21	13.2	36	15.2	1.47	0.23

Upper 4s Lower 5s	2	2.6	6	3.8	8	3.4	0.23	1.00 I
Upper 5s Lower 4s	1	1.3	5	3.1	6	2.5	0.74	0.67 I
Upper 4s	7	9.0	14	8.8	21	8.9	0.00	1.00
All 5s	4	5.1	3	1.9	7	3.0	1.92	0.22 I
Upper 5s only	0	0	2	1.3	2	0.8	0.99	1.00 I
Lower 4s only	1	1.3	2	1.3	3	1.3	0.00	1.00 I
Total	78	100	159	100	237	100		
Additional extractions								
Nil	73	93.6	146	91.9	219	92.4	0.23	0.63
Superumeraries	5	6.4	3	1.9	8	3.4	3.28	0.12 I
Second permanent molar	0	0	2	1.3	2	0.8	0.99	1.00 I
First permanent molar	0	0	1	0.6	1	0.4	0.49	1.00 I
Deciduous	0	0	7	4.4	7	3.0	3.54	
Total	78	100	159	100	237	100		

Discussion

Numerous studies have examined the prevalence of extraction in orthodontic populations worldwide with an obvious paucity of data on the subject matter among African populations. This study is a retrospective study which reviewed extraction frequencies and pattern among orthodontic patients in a Teaching Hospital Orthodontic Clinic in Nigeria, West Africa. It was concerned only with those for whom extractions were done for the purpose of orthodontic correction.

Some justifiable clinical arguments for orthodontic extractions include the need for arch space for resolution of crowding^{26, 27} overjet reductions especially in camouflage treatment of Class II and Class III malocclusion^{26, 27}, correction of vertical discrepancy in reduced bite and anterior open bite cases²⁸, and in correction of bi-maxillary protrusion. The malocclusion type, patient's aesthetic preferences,

racial/ethnic facial morphological differences^{26, 29}; clinician's beliefs and philosophy as well as treatment modality are important considerations in extraction treatment. Interplay of these multiple factors has contributed to the complexity of the extraction decision and variation among orthodontic practitioners. Not surprisingly therefore, the frequency reports from previous studies have varied widely ranging from as low as 6.5% to 83.5%^{1, 29}. Despite this, Baumarind et al³⁰ observed a high degree of clinician agreement in the decision to extract or not in their study where 148 cases were assessed by 5 orthodontists.

The socio-demographic characteristics of this study subjects showed a slight female predominance, as has been reported previously among an orthodontic treatment seeking population^{1, 26, 29, 31} with a greater extraction

frequency observed in males than females, corroborating the reports from previous literature^{24,26,27,31} but at variance with Peck and Peck¹

The prevalence of orthodontic extraction in the current study was 53.2%. This frequency is interestingly higher than the findings of previous recent studies^{26, 28, 31} which evaluated extraction rates among orthodontic patients in America, Brazil and South Korea. This may be due to the more convex profile with associated skeletal and labial protrusions established in the African population.^{16, 17, 18, 32} A study by daCosta and Utomi et al²⁰ showed that increased overjet and crowded dental arches were the two most frequently seen occlusal anomalies among Nigerian orthodontic patients, with a need for extractions to resolve malocclusions. Extraction of teeth in the African population therefore, is likely to be carried out with less hesitancy due to the protrusive profile, with an aesthetically acceptable profile post treatment.

The high prevalence of extractions observed in this study corroborates the findings of Jacksons et. al.²⁶ who observed the odds of extraction to be 4 times more in African Americans when compared to the Caucasians; and potentiating the racial effect in extraction prevalence in orthodontic management. A regression analysis adjusting for confounding variables in same study revealed crowded dental arches, increased overjet, reduced overbite and race to be significant factors which influenced extraction prevalence and pattern in that particular study.²⁶

A study by Isiekwe GI et. al¹⁷ on the cephalometric assessment of the lip position in a normal Nigerian adult populations showed upper and lower lip to E- Plane of 3.21mm and 6.76mm respectively, with the males being slightly more protrusive. This is considerably higher than those of previous studies in other populations.^{33,34} Against this backdrop therefore, alongside the high prevalence of anterior open bite in the Nigerian population^{19, 20, 35, 36}, compared to other populations³⁷⁻³⁹, may be reasons for the increased extraction frequency observed in this study as it often associated with proclined upper and lower anterior teeth. Here therefore lies important information for the orthodontist when extraction treatment is considered for the Nigerian/African patient.

The prevalence of extraction observed in the current study was however comparable with that reported by Weintraub et al² (54%) among orthodontists in America; significantly higher than the findings of more recent studies among the whites. The study subjects included patients treated between years 1947 to 1984 and may be responsible for the high prevalence reported considering the fact that a downward in extraction rates over the years has been observed²⁹.

Corroborating reports from previous studies^{2, 21, 26, 28, 29} the first premolars had the highest proportion of tooth extractions, accounting for over 70% of all extracted teeth in the present study. Further reviewing the pattern of extraction in this study, in agreement with other studies, the extraction all 4 first premolars was found to be most predominant extraction pattern^{23,26} however, at variance with some others^{28, 29, 31} who reported the extraction of maxillary first premolars to be most predominant. Consequently, therefore extractions were most frequent in patients with Class I malocclusion in the current study.

Following the extraction of all first premolars was 2-unit extraction of the upper first premolars, and thirdly the extraction of mandibular first premolars. The extraction of maxillary premolars preferably 1st premolars is an acceptable protocol in the camouflage treatment of Class II malocclusion with associated reduction in treatment time.^{40, 41} Similarly; mandibular premolar extraction is used in the camouflage treatment of Class III malocclusion. The higher prevalence of Class II malocclusion was observed in this study compared to Class III, with attendant treatment protocol and therefore may account for overall higher prevalence of extraction observed in the maxilla compared to the mandible in the current study. The extraction of molars was uncommon in the study, possibly due to a decline in caries occurrence, as caries compromise is usually a strong indicator in the choice of molar extraction in orthodontic management.⁴²

Some primary teeth were extracted, with the primary canine being the most commonly extracted tooth in this study, usually as part of an interceptive protocol in the management of crowding in the mixed dentition.

This study has provided information on extraction pattern as an adjunct to orthodontic treatment among a population of patients of African descent. As the argument for and against extractions continue, this prevalence study still remains relevant in informed decision making in the management of orthodontic patients. Secondly, cephalometric assessments of parameters such as SNA, SNB, and lip dimensions which affect extraction decisions were not measured. Therefore, further studies are suggested, prospective preferably to determine the extraction pattern in a larger population of Africans taking into consideration the aforementioned limitations.

Conclusions

In this single centre study, we assessed the prevalence of orthodontic extraction from the case files of 340 orthodontic patients over a 5 year period. A prevalence of 52.3% was observed, with Class I malocclusion being the most predominant malocclusion pattern. A total of 384 teeth were extracted with the first premolars being the most frequently extracted teeth, accounting for 72.9% of all extracted permanent teeth. The primary canine was the most common primary tooth extracted. The commonest pattern of extraction observed was the extraction of all first premolars. These results will aid clinicians in making extraction decisions in the management of orthodontic patients of African descent.

Further studies involving cephalometric assessment of the effect of tooth extraction of facial profile should be carried out to further determine the effect of extraction of this population.

Contributors

All authors contributed equally

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Conflict of Interest

None declared

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Comparison of Shear Bond Strength of an Orthodontic Adhesive with a Restorative Adhesive

Adu-Poku F^a, Quartey-Papafio N^b, Amoah GK^a, Newman-Nartey M A^a, Osafo SA^b

Abstract

Background: Bonding of orthodontic brackets to enamel surface using composite resins is a significant improvement in clinical orthodontics. Bond strength tests are categorized as tensile or shear bond strength. The objective of the study was to determine and compare shear bond strength of orthodontic adhesive with a proposed restorative adhesive.

Methods: Eighty extracted human premolar teeth from patients seeking orthodontic treatment were used. Teeth were divided into four major groups consisting of 1st and 2nd upper and lower premolar teeth. Enamel surface of each tooth was etched and bonded with the brackets using orthodontic and restorative adhesives and a light emitting diode device. Shear bond strength of adhesives were measured using MARK-10 testing machine. Adhesive remnant index (ARI) scores were also determined.

Mean bond strength values between groups of teeth were analyzed using One-way analysis of variance (ANOVA) and ARI data analysed using Chi square test.

Results: Shear bond strength values for 1st and 2nd of lower premolar teeth bonded with Resilience were 5.96 and 5.75MPa respectively. The values for DenFil adhesive were 5.66 and 7.09 MPa respectively. Shear bond strength values for 1st and 2nd upper premolar teeth for Resilience were 6.22 and 7.67 MPa. For DenFil the values were 7.14 and 7.57MPa. There were no significant differences ($p>0.05$) in the shear bond strength values of all groups of teeth for both adhesives.

Conclusion: Shear bond strength values of DenFil were comparable to Resilience. DenFil may be clinically acceptable as an orthodontic adhesive.

Keywords: Shear bond strength, Orthodontic adhesive, Restorative adhesive, Orthodontic brackets, Adhesive remnant index

Authors' Affiliations

^aDepartment of Orthodontics/Paedodontics, University of Ghana Dental School, College of Health Sciences, Accra.

Phone: +233(0)509037205

^bDepartment of Biomaterial Science, University of Ghana Dental School, College of Health Sciences, Accra.

Correspondence

N Quartey-Papafio

Department of Biomaterial Science, University of Ghana Dental School, College of Health Sciences, Accra.

Email: qpapafio@yahoo.co.uk

Introduction

Bond strength can be defined as force per unit area required to break a bonded assembly with failure occurring in or near the adhesive/adhered interface.¹ It is commonly reported in units of mega Pascal's (MPa). Almost all bond strength tests are categorized as tensile or shear bond strength.² The purpose of either a tensile (micro tensile) or shear bond strength test is to establish the strength of a bonding adhesive system in a numerical value.³ Shear testing is important since it presents reliable results and is more representative in a clinical situation.³ Although shear testing is more widely

used, it might also be more technique sensitive than tensile testing⁴, because shear bond strength measurements are influenced significantly by the direction of debonding force, indicating the need for control and standardization of this testing parameter in orthodontic shear bond strength testing.⁵

The bond strength of adhesive and attachments should be sufficient to withstand the forces of mastication, the stresses exerted by the arch wires, and patient abuse. Also bond strength should be high enough to resist accidental debonding during treatments and allow for control of tooth movement in all three planes of space. At the same time, the bond strength should be low enough to allow for bracket debonding without causing damage to the enamel surface.^{6,7}

Reynolds⁸ suggested that for an adhesive system to have acceptable clinical performance, *in vitro* bond strength of 5.9-7.8 MPa is required. Although strong bond strength is desirable in orthodontic practice, however bond strength values higher than 9.7 MPa can lead to enamel fractures.

In 1989, O'Brien et al⁹ in an *in vivo* comparative study used a visible light-activated direct-bonding

material. The improvement in light-activated resins benefitted resins designed for both restorative dentistry and bonding of orthodontic brackets. At present, there are several resin systems, scientifically proven to be effective and intended specifically for bonding orthodontic attachments. However, although orthodontic adhesives have a basic formula similar to that of resin composites commonly used in clinical restorative procedures, they are more expensive and are commercially available only from suppliers dealing exclusively with orthodontic materials. For this reason, and possibly also because of their different consistency, not all professionals are familiar with their use and do not choose to use them on a regular basis.¹⁰

Orthodontic bonding to enamel surfaces as compared to banding results in significant improvements in treatment such as greater patient comfort, elimination of the need for pre-treatment tooth separation, decreased gingival irritation, improved oral hygiene and aesthetics and reduced chair time.¹¹ Direct bonding of orthodontic brackets to the surface of the teeth has become common practice; however between 0.5 to 55.8 per cent of bonds fail.⁹ Hobson et al¹³ assessed the bond strength to surface enamel for different tooth types. Bond failure of a no-mix adhesive during orthodontic treatment was published by Adolfsson et al.¹⁴ Bond failure may be both inconvenient and expensive for the patient and orthodontist and can compromise orthodontic treatment. A better understanding of the reasons for orthodontic bond failure may lead to improved techniques, which could reduce this constant.¹³ Various factors can affect bond failure, including operator technique and manual dexterity, patient behaviour, variation in the enamel surface, the type of etchant used and its duration of application, the adhesive used, bracket properties, and ligation forces.¹⁵ Most of these factors are applicable in clinical conditions. However, most of these studies were carried out *in vitro*. Under these conditions, variation in enamel surface may also affect bond strength.¹⁶ It is obvious that *in vitro* studies cannot provide adequate information regarding combination of forces and numerous factors involved in orthodontic treatment, but they are useful as a guide for the clinician in the selection of the bracket/adhesive system to be used in clinical settings.⁷

At the School of Medicine and Dentistry orthodontic clinic situated at the college of health sciences, Korle Bu, the orthodontic adhesive runs out of stock quite frequently. There have been

suggestions to look for an alternative adhesive. An alternative material, a restorative adhesive which is readily available and relatively affordable but having adequate shear bond strength with a common monomeric system as the orthodontic adhesive could be preferred for orthodontic bonding of brackets in case of the shortage of orthodontic adhesives.

The primary aim of this study was to determine if the shear bond strength of a restorative adhesive is adequate for orthodontic bonding using extracted human premolar teeth.

Null hypothesis

There is no difference in the shear bond strength of the restorative adhesive and the orthodontic adhesive.

Materials and Methods

The proposal for the study was approved by the Ethical and Protocol Review Committee of the College of Health Sciences, University of Ghana to conduct the study.

The study was cross sectional laboratory based conducted at University of Ghana Dental School. Eighty extracted 1st and 2nd human premolar teeth from patients seeking orthodontic treatment were used. The teeth were divided into four major groups which consisted of 1st and 2nd upper and lower premolar teeth. Each group consisted of twenty teeth, which was divided into equal number of 10 teeth for each material.

Buccal surfaces of teeth were polished with flour of pumice extra fine (Kemdent) and rubber prophylactic cups with a low-speed hand piece and water, rinsed and air dried. After etching the enamel buccal surface with a 37% phosphoric acid solution (actino gel) for 30 seconds, and rinsing for 10 seconds. Teeth were dried with oil-free air for 10 seconds until a frosty white appearance of the etched enamel was observed.¹⁷ Stainless steel pre-adjusted edgewise premolar brackets of slot size 0.022x0.028 inches (*MBT BIONIC, ORTHOTECHNOLOGY US*), with base surface area of 10.9 mm² were used (Ortho Technology Company, USA).

The adhesives were manipulated in accordance with the respective manufacturers' instructions and were applied to the bracket bases so as to cover them completely and uniformly. Each bracket was positioned over the mid-point of the clinical crown on buccal surfaces of the prepared premolar teeth and pressed firmly with light force onto the surface. They were pressed against the surface of the premolar until a standardized 0.5mm adhesive thickness was

obtained under the brackets to prevent bond strength variation.

The materials used in this study and their composition were two commercial resin based adhesive

systems (Resilience and DenFil) of different matrix chemistry and particulate filler type and loading as indicated in Table 1.

Table 1. Materials used in the study

Materials	Matrix	Filler content (% w)	Filler type and size	Manufacturer
Resilience (Orthodontic adhesive)	Bis-GMA	Small	glass particle filler	Ortho Technology (U.S.A)
DenFil (Restorative adhesive)	Bis-GMA TEG-DMA	80	Barium-aluminosilicate < 1µm. Fumed silica 0.04µm	Vericom Co.Ltd (Korea)

Determination of the shear bond strength

A mechanical testing machine a MARK-10 Force Gauge, Model M5-500 with motorized test stand (ESM 301L USA) connected to a computer was used to measure the debonded force.

To calculate shear bond strength, the debonding force value (dN) was divided by the surface area of the bracket base converted to shear bond strength (Mpa).

Determination of Adhesive Remnant Index (ARI) scores

After the debonding process, the enamel surfaces and bracket bases of each tooth were inspected and examined under stereomicroscope 10 x magnification to determine the amount of residual adhesive remaining on each tooth. The adhesive remnant index scores were determined by a method adopted by Årtun and Bergland¹⁸ where: zero (0) indicates no amount of composite adhered to the enamel surface; one (1) indicates less than half of the composite adhered to the enamel surface; two (2) indicates more than half of the composite adhered to enamel surface and three (3) indicates composite adhered to the entire enamel surface.

Statistical analysis

Data were analyzed using One-way analysis of variance (ANOVA) from the SPSS (statistical package of social science) software version 22. The adhesive remnant index (ARI) scores data were

analysed using Chi square test.

Results

The mean and standard deviation of shear bond strength values recorded in MPa for every group of premolar teeth bonded with both adhesives that were used in this study were presented in Table 2. Shear bond strength values for 1st and 2nd premolar lower teeth for both adhesives, Resilience and DenFil were presented. In addition, the shear bond strength values for 1st and 2nd premolar upper teeth for both adhesives, Resilience and DenFil were presented.

One-way analysis of variance (ANOVA) test indicated no significant differences ($p > 0.05$) in the mean values of the shear bond strength of all the groups of upper and lower premolar teeth for both adhesives.

Table 3 indicates the mean shear bond strength values of the total number of 1st and 2nd premolar teeth for both lower and upper teeth bonded with the Resilience and Denfil adhesives.

There was no significant difference ($p > 0.05$) in the mean values of the shear bond strength between the groups of upper and lower premolar teeth for both adhesives.

Figure 1 indicates the means and error bars of the shear bond strength values between all the groups of teeth for both adhesives.

Table 4 indicates the adhesive remnant index (ARI) scores of 1st and 2nd premolar for both lower and upper teeth bonded with the Resilience and Denfil adhesives.

The evaluation of the ARI scores indicated statistically insignificant difference in bond failure site among the two groups, Chi Square test $P = 0.184$.

Table 2. Shear bond strength (MPa) of 1st and 2nd upper and lower premolar teeth using Resilience and DenFil adhesives

Teeth Type	Shear bond strength	
	Resilience	DenFil
Upper 1 st premolar	6.22 (1.75)	7.14 (2.30)
Upper 2 nd premolar	7.67 (2.74)	7.57 (3.56)
Lower 1 st premolar	5.96 (1.29)	5.66 (1.34)
Lower 2 nd premolar	5.75 (1.27)	7.09 (2.10)

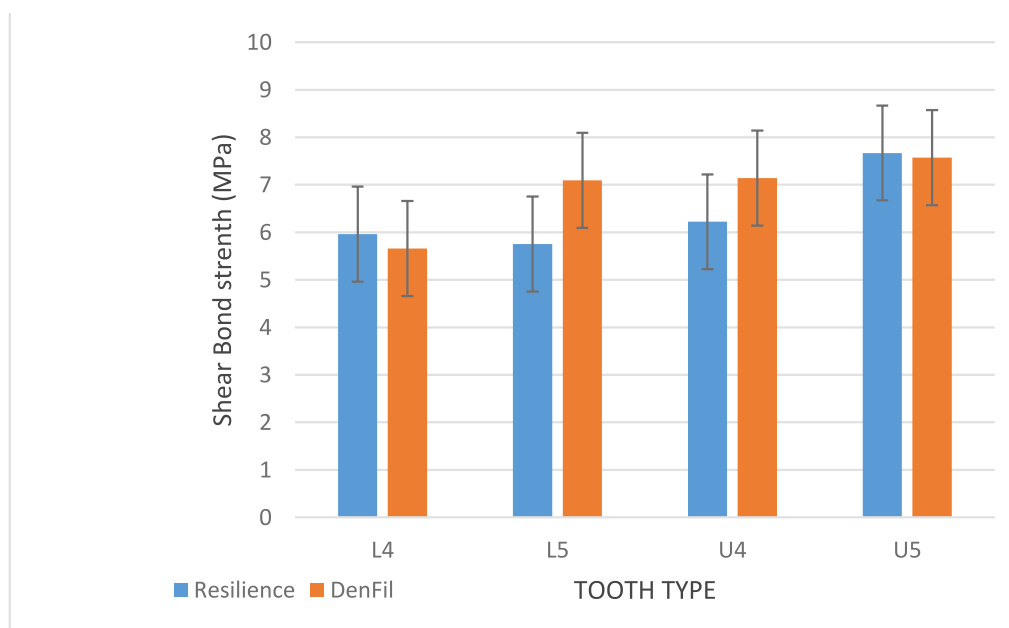
Table 3. Shear bond strength values of the total number of premolar teeth with the two adhesives

Adhesives	N	Mean	Std. Deviation	Minimum	Maximum	P-value
Resilience	40	6.40	1.94	3.80	12.29	0.35
DenFil	40	6.86	2.47	3.85	14.40	
Total	80	6.63	2.22	3.80	14.40	

Table 4. Adhesive remnant index (ARI) scores

Adhesives	Scores			
	0 N (%)	1 N (%)	2 N (%)	3 N (%)
Resilience	0	6 (15)	14 (35)	20 (50)
DenFil	0	13 (32.5)	11 (27.5)	16 (40)

Chi Square test P=0.184

**Fig.1.** Means and error bars for shear bond strength of two adhesives for the two sets of teeth

Discussion

Numerous studies on different aspects related to the direct bonding of orthodontic systems exist. However, there are few studies in the literature on the use of restorative systems for bonding orthodontic accessories.^{18,19} The present study determines the shear bond strength of orthodontic and restorative adhesives as indicated in Table 1 using a mechanical testing machine Mack 10. Light-emitting diode (LED) curing light was used for polymerization of the adhesives as recommended by Rueggeberg et al.²⁰

The shear bond strength was analysed since it presents reliable results and more representative of clinical situation.³ The adhesives were used to attach stainless steel edgewise premolar bracket to the buccal surfaces of teeth divided into two groups of maxillary and mandibular.

The results of the study as indicated in Table 2 shows that the shear bond strength of the restorative adhesive (DenFil) were generally higher than that of orthodontic adhesive (Resilience). However, there was no significant difference between all the groups. The higher values of shear bond strength of the DenFil adhesive may be due to the difference in matrix chemistry of the two adhesives and its filler loading (Table 1).

As indicated in Table 2, the results of this study shows that the mean shear bond strength values of the 1st and 2nd upper teeth of Denfil adhesive was higher than those of the Resilience adhesives, however the differences were not significant ($p < 0.05$). The trend was similar for the 1st and 2nd lower teeth when bonded with both adhesives. This observation is supported by the results of other previous studies.^{12,13,16,21,22}

The standard deviations found in this study varied between 1.27 and 3.56, suggesting greater reliability in the standardization of the method used.

Studies by Reynolds et al.⁶ are consistent with the results of this study. Both adhesives used in this study, obtained mean shear bond strength values ranging from 6.40 MPa- 6.86 MPa, similar to the findings of various studies.^{10, 23, 24, 25, 26} The 2nd upper premolar bonded with Resilience showed the highest shear bond strength value of 7.67 MPa which is similar with results obtained in other studies. Results of the study were in agreement to other studies that used LED curing light.^{8,28, 29}

In 1989, Greenlaw et al.²³ although stated that there was no universally accepted minimum clinical bond strength, various studies have mentioned bond strengths ranging from 5 MPa to 10 MPa as being

adequate for clinical situations.^{30,31}

When assessing five different adhesive systems used in Orthodontics, Souza et al.³² obtained a mean shear bond strength value for Transbond XT, which differs from the result this study and another study by Sobrinho et al.³³

Bracket failure occurred between 3.80 MPa and 14.40 MPa in this study as indicated in Table 2. This range is similar to the values obtained by several authors.^{23, 24, 30, 34} This may be due to the larger amount of aprismatic enamel on premolars which has been shown to affect their micromechanical bond strength.³⁵

A similar higher incidence of bracket failure in the mandibular arch is well documented in the literature and can be attributed to greater masticatory loads in the mandibular arch than in the maxillary arch.^{36, 37} This is most likely due to incomplete polymerization of the adhesive resin below the metal base of the bracket because the curing light cannot reach the adhesive behind the bracket mesh.³⁸

The adhesive remnant index (ARI) scores of the present study is shown in Table 4. The scores interpret the amount of residual adhesive covering the enamel surface after debonding of brackets. As indicated in Table 4 the number of enamel surfaces with a score of three (3) and two (2) was higher for Resilience than Denfil. However, the number of enamel surfaces with a score of one (1) was higher in Denfil (32.5%) than Resilience (15%). The differences in ARI scores between both adhesives could possibly be attributed to material composition differences and filler type and loading (Table 1).

The findings of the ARI scores of this study are based on a type of ARI assessment after bracket debonding. This type is referred to as the bracket-adhesive interface failure in which the residual adhesive remains on the enamel.^{39,40} Hence, in ARI assessment more chair time is required to remove the residual adhesive on the enamel surface using specific burs which do not damage the tooth. In addition, enamel fractures are avoided, and tooth's integrity is maintained.^{31,40,41}

Conclusion

This research clearly demonstrates that both adhesives: Resilience (OrthoTechnology, USA) and DenFil (Vericom Co. Ltd, Korea) showed

adequate shear bond strength values for orthodontic bonding of brackets representing 6.40 MPa and 6.86 MPa respectively.

The results of this study indicate that DenFil is comparable with Resilience and can be used as a guide in choosing the right adhesive for clinical practice and a sound base for further investigation.

The results of this study provide an alternative material, DenFil for orthodontic bonding of brackets in the absence of the orthodontic adhesive, Resilience

Contributors

APF was responsible for the overall study in, data acquisition and write up. **QPN** responsible for data acquisition, interpretation and analysis. In addition, responsible drafting and write up of the article. **AGK** was responsible for research design and clinical application of the study. **MNN** responsible for research topic and design of the study. In addition contributed to the clinical application. **OSA** contributed to the write up and overall editing of the article.

Contributors

All authors contributed equally

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Acknowledgements

In acknowledgements section, it is suitable to list all contributors who do not meet the criteria for authorship, such as a person who provided purely technical help, writing assistance, or a department head who provided only general support. Financial and material support should also be acknowledged.

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Tables

Each table should be typed in double-space on a separate sheet of paper. Tables not submitted as photographs must be numbered consecutively (Arabic numerals) in the order of their first citation in the text, with a brief but self-explanatory title for each.

Each column should have a short or abbreviated heading. Explanatory matters are placed in footnotes, not in the heading. In footnotes all nonstandard abbreviations that are used in each table should be explained adequately. Statistical measures of variations should be identified such as standard deviation and standard error of the mean. Be sure that each table is cited in the text. If data are used from another published or unpublished source, it is necessary to obtain permission and acknowledge them fully.

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Figures should be professionally drawn and photographed; freehand or typewritten lettering is unacceptable. Instead of original drawings, X-ray films, and other material, sharp, glossy, black-and-white photographic prints of high quality are necessary, usually 127x 173 mm (5x7 in) but no larger than 203x254 mm (8x10 in) For color illustrations negatives or positive transparencies are provided, along with color prints. It is preferable to have the photograph in portrait form rather than in landscape form to fit easily into one column. Letters, numbers and symbols in photographs should be clearly legible.

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Measurements of length, height, weight, and volume should be reported in metric units, i.e., meter(m), gram(g), or liter(l) or their decimal multiples. Milliliter or deciliter should be expressed as ml or dl. Red and white blood cell counts are to be expressed as $\times 10^6$ and $\times 10^9$ respectively. Temperatures should be given in degrees Celsius and blood pressures in millimeters of mercury (mmHg). All hematological and clinical chemistry measurements should be reported in the conventional system or in terms of the International System of Units (SI).

Abbreviations and symbols

Only standard abbreviations are used in the text while avoiding abbreviations in the title and abstract. The full term for which an abbreviation stands should precede its first use in the text unless it is a standard unit of measurement. Year, month, day, hour, minute and second should be abbreviated as yr, mon, d, h, mm, and s in tables respectively.

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Appendix 1:

Declaration of Originality and Transfer of Copyright

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