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Original Article

Frequency, Pattern and Rationale of Tooth Extractions Among Orthodontic Patients: A 10-year Tertiary Institution Experience

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ABSTRACT

Background and objectives: Tooth extractions are a vital aspect of orthodontic management that enables the orthodontist to achieve good aesthetics and function as well as long term treatment stability for the patient. Extractions may be necessary for various reasons among which are tooth size arch length discrepancy (TSALD), increased overjet and facial profile. The aim of this study was to determine the prevalence, pattern and rationale of tooth extraction among orthodontic patients attending the Orthodontic Unit of the Department of Child Dental Health, University of Port Harcourt Teaching Hospital. **Methods.** A retrospective study of a cohort of patients who attended one of the outpatient Orthodontic Clinics in the Department of Child Dental Health, University of Port Harcourt Teaching Hospital, Port Harcourt, Nigeria between 2011 and 2021. Data was collected from the patients' records. **Results.** A total of 175 patients comprising 70(40%) males and 105(60%) females were included in the study. 67(38.3%) patients had at least one extraction. Twenty-eight (41.8%) extraction cases had extraction of the first premolars. Two-unit extractions of the maxillary first premolars (13, 46.4%) was the most frequent extraction pattern. Eight (29.6%) had extraction of primary canines only. Twenty-seven (40.3%) participants had extractions due to increased overjet. Over a third of the patients had extraction of at least one tooth. **Conclusion**. Two-unit extractions of maxillary first premolar was the commonest extraction pattern. Increased overjet was the commonest reason for extraction.

Keywords. Orthodontic patients, Extraction pattern, UPTH, Nigeria.

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INTRODUCTION

Extraction for orthodontic purposes alone is a very controversial topic. An appropriate extraction pattern is an important factor to consider for good treatment outcome [1,2]. Therefore, it is important to properly plan these extractions in order to have a successful treatment outcome in terms of function, aesthetics as well as long term stability. The decision to extract is vitally important because it is irreversible.

Edward H. Angle laid emphasis on the non-extraction approach to orthodontic treatment to achieve facial balance stating that bones will always form wherever teeth are found according to Wolff's law [3]. He believed that "the best balance, the best harmony, the best proportions of the mouth in its relation to the other features require that there shall be a full complement of teeth, and that each tooth shall be made to occupy its normal position—i.e., normal occlusion" [4]. Calvin Case in 1911 opposed this, and advocated that extraction was necessary to unravel crowding and also to achieve stability [3,5]. Tweed also proposed that some patients are better managed with extraction of the first premolars emphasizing extraction as a last resort after careful selection of patients for improved aesthetics and treatment stability [6]. This is because failure to extract at the beginning of treatment can almost always be corrected later on by extracting if the need arises. However, wrong decision of extracting gives no room for later correction [6].

Extraction for orthodontic purposes is done for various reasons. These can be classified into demographic factors, clinical factors, treatment factors, philosophical and psycho-social factors [2,3,7-19]. The demographic factors include age, gender and ethnicity/race of the patients [13,19]. Clinical factors are tooth size arch length discrepancy (TSALD), Bolton ratio, facial profile and pattern, increased overjet, tooth asymmetries, skeletal maturation, maxillomandibular relationships, supernumeraries and periodontal health status of teeth [2,3,7]. Other clinical factors include crown and root form and length of the teeth, caries rate, oral hygiene status, hypodontia, tooth impaction, previous trauma or heavily restored teeth, cleft lip and palate, curve of Spee, anchorage requirements, adjusting the torque of the anterior teeth, magnitude and vector of tooth movement [2,3,7-11]. Treatment factors include treatment time, treatment trends and /or techniques [3,15-18,20,21]. Philosophical and psycho-social factors are aesthetics, personal philosophy of the orthodontist, patient's cooperation, socio-economic status and general attitude of patient to treatment [9,10,13,14,22]. Correct timing of extractions may sometimes lead to the spontaneous alignment of teeth, as may occur after extraction of a supernumerary tooth [3].

The first premolar is the teeth most commonly extracted for orthodontic purposes [1,2,8]. This is due to its position within the dental arch which after extraction allows for eruption and alignment of the permanent canine [3,23]. These extractions are carried out particularly to correct crowding, severe midline discrepancies or asymmetric molar relationships [1,2]. This makes alignment and retraction of the anterior teeth easier with simple biomechanics, undemanding control of anchorage and preservation of the contact point between second premolar and first molar [1,2].

The purpose of this study was to determine the frequency and pattern of as well as rationale for tooth extractions among orthodontic patients at the Orthodontic Unit of the Department of Child Dental Health, University of Port Harcourt Teaching Hospital, Port Harcourt, Rivers State, Nigeria over a duration of ten (10) years.

METHODS

Ethical approval was obtained from the Research and Ethics Committee of the hospital prior to commencement of this retrospective study. It comprised one hundred and seventy-five patients who attended one of the outpatient Orthodontic

Clinics in the Department of Child Dental Health, University of Port Harcourt Teaching Hospital, Port Harcourt, Nigeria. Socio-demographics, extractions done, type of tooth extraction and reasons for extraction were obtained from patients' folders and documented on a record sheet. Patients with incomplete records, special need patients, patients with craniofacial anomalies like cleft lip and palate and patients who started their treatment elsewhere were all exempted from the study. Analysis of data was carried out using IBM Statistical Package for Social Sciences (SPSS) Statistics for Windows version 25.0. (Armonk, NY: IBM Corp).

The results were presented using frequencies, percentages and proportions for categorical variables and means and standard deviations for continuous variables. Chi-square was used to test association between variables. Statistical significance was determined at 95% confidence interval and at $p \leq 0.05$.

RESULTS

A total of 175 patients comprising 70(40%) males and 105(60%) females with a mean age of 13.9±7.6years were included in the study. Majority of the patients were children and adolescents (<18years) (137, 78.3%) and within the 10-19year age bracket. The modal age was 8years (19, 10.9%). Table 1 shows the age and gender distribution of the study population.

Table 1: Age ***and gender distribution of patients***

Age (years)	Male N (%)	Female N (%)	Total N (%)
0-9	25 (35.7)	30 (28.6)	55 (31.4)
10-19	40 (57.1)	49 (46.7)	89 (50.9)
20-29	2 (2.9)	18 (17.1)	20 (11.4)
30-39	3 (4.3)	7 (6.7)	10 (5.7)
40-49	0 (0)	1 (0.9)	1 (0.6)
Total	70(100.0)	105(100.0)	175(100.0)

A total of 67 patients (38.3%) had tooth extractions. Majority of the subjects were females (35, 52.2%). Most of the cases had extractions of permanent teeth (37, 52.2%) while only 3(4.5%) had extraction of supernumeraries. Tables 2a and 2b display the prevalence of extraction.

Table 2a: Frequency of extractions of patients

Extraction	Male N (%)	Female N (%)	Total N (%)
Yes	32(47.7)	35(33.3)	67(38.3)
No	38(54.3)	70(66.7)	108(61.7)
Total	70(100.0)	105(100.0)	175(100.0)

Table 2b: Frequency of extractions of primary and permanent teeth of patients

Extracted Teeth	N (%)
Primary teeth only	27 (40.3)
Permanent teeth only	37 (52.2)
Supernumeraries	3 (4.5)
Total	67 (100.0)

Twenty-eight (41.8%) patients had extractions of the first premolars, 3(4.5%) second premolars, 3(4.5%) supernumeraries, 3(4.5%) third permanent molars, 2 (3%) had extraction of first permanent molars and only 1(1.5%) had extraction of the lower incisor (Fig 1).

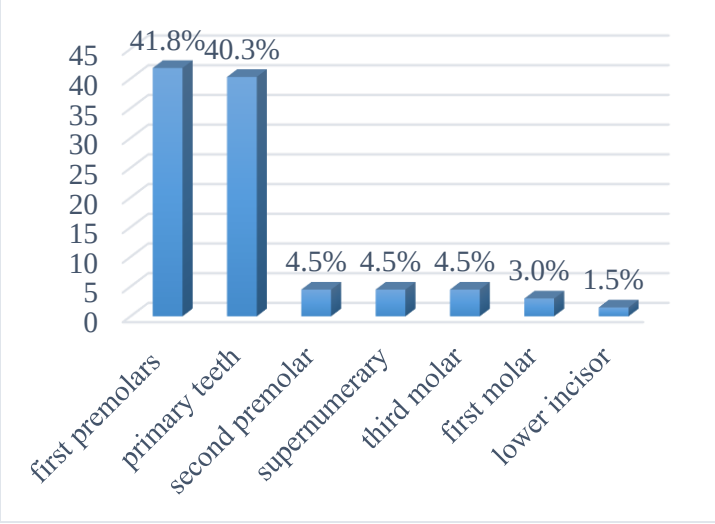

Fig 1. Extraction pattern of teeth

Thirteen (46.4%) of the 28 premolar extractions were upper first premolar extractions only, 10 (35.7%) had extraction of both upper and lower first premolars and just 5 (17.9%) had extraction of only lower first premolars.

Twenty-seven (40.3%) patients had extractions of primary teeth. Extraction of the primary canine (8, 29.6%) was the most prevalent. Tables 3a and 3b show patterns of extraction of permanent with supernumerary and primary teeth with their age and gender distribution; respectively.

Most study participants had extractions due to increased overjet (27, 40.3%) and crowding (20, 29.9%). Only 3 (4,5%) had extractions due to the presence of supernumeraries (3, 4.5%). Fig 2 displays reasons for extraction.

Table 3a: Crosstabulation of extraction pattern of permanent teeth and supernumeraries with age and gender of patients

Tooth	AGE (years)										
	0-9		**10-19**		**20-29**		**30-39**		**40-49**		**Total**
	M	**F**	**M**	**F**	**M**	**F**	**M**	**F**	**M**	**F**	**Total**
	N/%	**N%**	**N%**	**N/%**	**N/%**	**N/%**	**N/%**	**N/%**	**N/%**	**N/%**	**N/%**
PM1	**0 (0.0)**	**0 (0.0)**	**7(77.8)**	**10(90.9)**	**2(100.0)**	**6(85.7)**	**1(20.0)**	**2(50.0)**	**0(0.0)**	**0(0.0)**	**28(70.0)**
PM2	**0(0.0)**	**0(0.0)**	**0 (0.0)**	**0 (0.0)**	**0 (0.0)**	**1(14.3)**	**1(20.0)**	**1(25.0)**	**0(0.0)**	**0(0.0)**	**3(7.5)**
M3	**0(0.0)**	**0(0.0)**	**0 (0.0)**	**0 (0.0)**	**0 (0.0)**	**0(0.0)**	**2(40.0)**	**1(25.0)**	**0(0.0)**	**0(0.0)**	**3(7.5)**
M1	**0(0.0)**	**0(0.0)**	**1(11.1)**	**0 (0.0)**	**0 (0.0)**	**0 (0.0)**	**1(20.0)**	**0(0.0)**	**0(0.0)**	**0(0.0)**	**2(5.0)**
I2	**0 (0.0)**	**0 (0.0)**	**0 (0.0)**	**1(9.1)**	**0 (0.0)**	**0 (0.0)**	**0 (0.0)**	**0 (0.0)**	**0(0.0)**	**0 (0.0)**	**1 (2.5)**
Sup	**0 (0.0)**	**2(100.0)**	**1(11.1)**	**0 (0.0)**	**0 (0.0)**	**0 (0.0)**	**0 (0.0)**	**0 (0.0)**	**0(0.0)**	**0(0.0)**	**3 (7.5)**
Total	**0 (0)**	**2(100)**	**9(100)**	**11(100)**	**2(100)**	**7(100)**	**5(100)**	**4(100)**	**0(0)**	**0(0)**	**40(100)**

PM1=First premolars, PM2=Second premolars, M3=Third molars, M1=First permanent molars, I2=Lateral incisors, Sup=Supernumerary teeth

Table 3b: Crosstabulation of extraction pattern of primary teeth with age and gender of patients

Tooth	AGE (years)										
	0-9		10-19		20-29		30-39		40-49		Total
	M	F	M	F	M	F	M	F	M	F	N/%
	N/%	N/%	N%	N/%	N/%	N/%	N/%	N/%	N/%	N/%	
Ci	1(20.0)	1 (25.0)	0(0.0)	0(0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0(0.0)	0 (0.0)	0 (0.0)	2(7.4)
Li	1 (20.0)	1 (25.0)	0(0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	2 (7.4)
Ca	0 (0.0)	0(0.0)	5(45.5)	2(33.3)	0(0.0)	1(100.0)	0(0.0)	0 (0.0)	0 (0.0)	0(0.0)	8(29.6)
D & E	0(0.0)	0(0.0)	1(9.1)	1(16.7)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	2(7.4)
Li & Ca	1(20.0)	1(25.0)	1(9.1)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	3(11.1)
Ci & Li	1(20.0)	0 (0.0)	2(18.2)	2(33.3)	0 (0.0)	0(0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	5(18.5)
Ca & D	1 (20.0)	1(25.0)	1(9.1)	0 (0.0)	0 (0.0)	0(0.0)	0(0.0)	0 (0.0)	0 (0.0)	0 (0.0)	3(11.1)
Ci, Li, D & E	0(0.0)	0(0.0)	1(9.1)	0 (0.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	1 (3.7)
Ci & Ca	0 (0.0)	0(0.0)	0 (0.0)	1(16.7)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (3.7)
Total	5 (100.0)	4 (100.0)	11 (100.0)	6 (100.0.0)	0 (0)	1 (100.0)	0 (0.0)	0 (0.0)	0(0.0)	0(0.0)	27(100.0)

Ci= Central incisor, Li= Lateral incisor, Ca= Canine, D= first primary molar, E= second primary molar

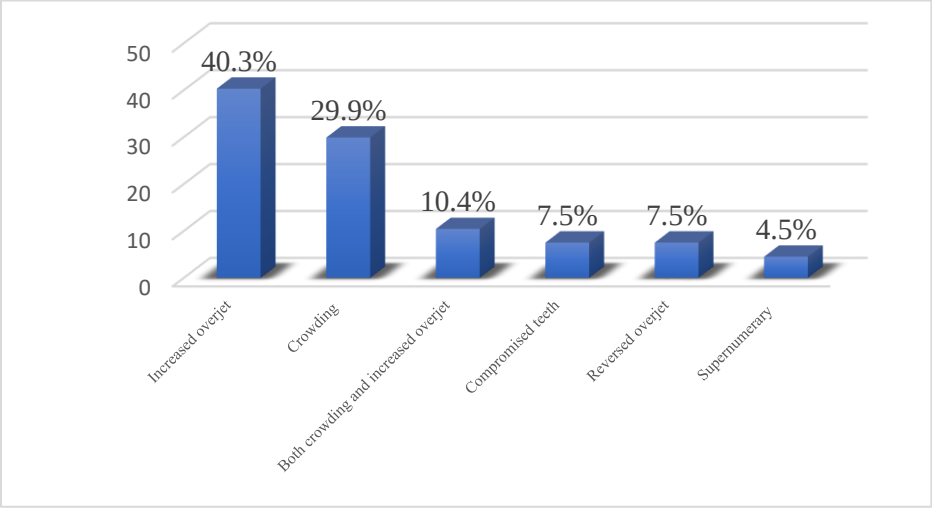

Fig 2: Reasons for tooth extraction

The major reason for extractions in female patients was increased overjet (45.7%) whilst crowding was most prevalent in males (40.6%). Majority of the participants that had extraction were within the second decade of life (37, 55.2%), followed by those in the first decade (11, 16.4%). None of the patients in the fifth decade (40-49) had extraction. Table 4 shows age and gender distribution with the reasons for extraction.

Table 4: Reasons for tooth extractions by age and gender

Tooth	AGE (years)										
	0-9		10-19		20-29		30-39		40-49		
	M	F	M	F	M	F	M	F	M	F	Total
	N%	N%	N%	N%	N%	N%	N%	N%	N%	N%	N%
IO	3 (50.0)	2 (20.0)	7 (31.8)	10 (66.7)	1 (33.3)	4 (50.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	27 (40.3)
Cr	3 (50.0)	5 (50.0)	8 (36.4)	2 (13.3)	2 (66.7)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	20 (29.9)
IO & Cr	0 (0.0)	1 (10.0)	3 (13.6)	1 (6.7)	0 (0.0)	2 (25.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	7 (10.4)
Com T	0 (0.0)	0 (0.0)	1 (4.5)	0 (0.0)	0 (0.0)	1 (12.5)	1 (100.0)	2 (100.0)	0 (0.0)	0 (0.0)	5 (7.5)
RO	0 (0.0)	0 (0.0)	2 (9.1)	2 (13.3)	0 (0.0)	1 (12.5)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	5 (7.5)
Sup	0 (0.0)	2 (20.0)	1 (4.5)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	3 (4.5)
Total	6 (100)	10 (100)	22 (100)	15 (100)	3 (100)	8 (100)	1 (100)	2 (100)	0 (0)	0 (0)	67 (100)

IO= increased overjet, Cr= Crowding, Com T= Compromised teeth, RO= Reversed overjet, Sup= Supernumerary

DISCUSSION

Extraction of teeth is a vital aspect of orthodontic management that enables the orthodontist to achieve good aesthetics and function as well as long term treatment stability for each patient. In the literature, extraction rate for orthodontic purposes varies from about 25% to 80% [9,20,24]. These rates vary with age, ethnicity/race, socio-economic factors, treatment trends and/or techniques, clinical experience of orthodontists and inclusion of third molars and primary teeth in the treatment plan [3,9,20,21,25]. In our study, the extraction rate was 38.3%. This is similar to a study by Jackson et al [20], in which the overall extraction rate was 37.4% in 2000 which however fell to under 25% in 2006. It is also similar to a study by Evrard et al [6] in which the extraction rate would have been 39% if survey was done about 15 years earlier of practice which reduced to 24% in 2019. However, our extraction rate is lower than that of studies carried out by daCosta et al [25] in Nigeria

with extraction prevalence of 53.2%, Bhattarai and Shrestha [23] in which the extraction rate of Nepalese male and female orthodontic patients was 45.8%, Dardengo et al [26] with extraction rate of 45.8% and also a study by Jung [27] among Korean patients in which extraction rate was 60.4%. The difference in extraction prevalence of our study and the one done in South-West Nigeria [25] could be due to the larger sample size and the fact that the number of teeth was used in their study, ours was based on number of patients which is what was commonly used in most studies [6,20,24] Konstantonis et al [21] had a much lower prevalence which may be due to ethnicity differences.[23]

In our study, more females had extractions than males which is in contrast with some studies [23,25,26] but it is in accordance with an earlier American study [28]. This finding was not statistically significant as was seen in other studies [21,23,25-27].

Extraction of the first premolar is the most common extraction done in orthodontics [1,2,9,20,25,26,29]. Our study is in agreement with this as extraction of the first premolar was the most prevalent accounting for almost half of all extractions. The greater prevalence of first premolar extraction was adduced to its position within the dental arch, its eruption pattern, the fact that its extraction allows for eruption of the permanent canine, correction of crowding, midline deviation and dentoalveolar protrusion [3,23,26]. Also, the fact that retracting the anterior teeth to close the extraction space has a more pronounced impact on facial profile than second premolar extractions [7]. The most frequently extracted permanent teeth were the maxillary first premolars in our study which is similar to other studies [25,26].

The most predominant pattern of extraction in our study was 2-unit extraction of maxillary first premolar. This is similar to some studies [9,26,27] but contrasts with other studies in which 4-unit extraction of the first premolars was the commonest [6,20,21,24,25]. The difference in our study and that done in South-West Nigeria could be due to the differences in the most common reasons for extraction in both institutions. It could be deduced that the most prevalent reason for extraction in the South-West Nigerian study was crowding.

First molars are the permanent teeth that are more prone to damage as they are often the first permanent teeth to erupt, have deep pits and fissures and are posteriorly positioned in the arch [3,30]. A small proportion of our patients had extractions of the first permanent molars which was due to gross caries with loss of tooth tissue which is in agreement with other studies [3,25].

Extraction of the primary canine was the most prevalent extraction of the primary teeth which is similar to the study by daCosta et al [25] in which extraction of the primary canine was the most prevalent of all primary teeth extracted as part of interceptive management of crowding in the mixed dentition stage.

The most prevalent reason for extraction in our study was increased overjet. This is dissimilar to studies by Traves et al [3] and Evrard et al [6] in which crowding was the main reason for extraction. The difference in the findings could be because of improved technology/techniques that can be used to unravel crowding such as growth modification and jaw expansion using orthopaedics, interproximal stripping the fact that extraction does not always guarantee stability of treatment and also soft tissue paradigm shift [24].

CONCLUSION

Over a third of our patients had extraction of at least one tooth. Extraction of the first premolars was the most predominant. Extraction of the maxillary first premolar was the most frequent tooth extraction. Two-unit maxillary first premolar extractions was the commonest pattern of extraction. Extraction of the primary canines was the most prevalent of the extraction of the primary teeth. The extraction of the lower permanent incisor was the least prevalent. Increased overjet was the commonest reason for extraction followed by crowding.

LIMITATIONS

Our study was carried out with the patients that attended only one orthodontic outpatient clinic; thus, it reflects the treatment options of one orthodontist.

RECOMMENDATION

We recommend further studies to be carried out with a larger sample size in order to compare extraction rates among orthodontic patients seen by different orthodontists over the years.

Disclaimer

The article has not been previously presented or published, and is not part of a thesis project.

Conflict of Interest

There are no financial, personal, or professional conflicts of interest to declare.

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