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**Orthodontic treatment outcome
with PAR Assessment rating**



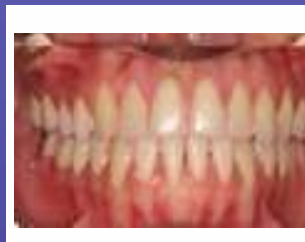
Digit sucking literature review



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orthodontic education**



**Non-surgical treatment of AOB with
MEAW**



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An Analysis of Orthodontic Treatment Outcomes at the Lagos University Teaching Hospital using the Peer Assessment Rating Index

Ayenakin O^a, Umeh OD^b, Odah GE^a, Utomi IL^b

Abstract

Background: There is a correlation between the demand and need for orthodontic treatment. Other factors may be responsible for the rising orthodontic demand rather than the actual need for treatment. An objective assessment is important to justify orthodontic treatment as well as evaluate treatment outcomes. The Peer Assessment Rating (PAR) Index was designed to objectively assess malocclusion and quantify the efficacy of treatment. The aim of this study was to assess malocclusion and evaluate treatment outcomes in Orthodontic patients at the Lagos University Teaching Hospital using the PAR Index.

Methods: This study was a retrospective cross-sectional study of patients treated at the Lagos University Teaching Hospital, Idi-Araba Lagos. A total of 43 pre and post-treatment study casts of patients treated over a period of one year were recruited for the study. This was obtained from the archives of the Orthodontics unit, LUTH. One principal investigator was calibrated for the PAR Index measurement. Selected casts were subsequently measured and scored using the PAR ruler and the UK weighting system of the PAR Index.

Results: A total of 43 pre and post-treatment study casts were analysed. A total of 31 (72.1%) out of the 43 treated cases showed great improvement with a 95% mean percentage reduction (mean reduction of 18.9) in malocclusion using the PAR Index. However, 11.6% of the subjects showed improvement and little improvement each, with a mean percentage reduction of 64.3% and 44.9% respectively. About 5% of the treated cases showed no improvement.

Conclusion: In this study, 72 % of patients managed at the orthodontics unit of the Lagos University Teaching Hospital showed great improvement in their occlusion.

Keywords: PAR, malocclusion, study casts, pre-treatment, post-treatment.

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Introduction

The demand for orthodontic treatment has notably increased all over the world, with waiting lists for treatment increasing, including in Nigeria^{1,2,3}. Several factors such as differences in the cultural perception of dental

aesthetics, improvements in treatment modalities, and advances in technology have been attributed to this^{4,5}. As a result, the science of the different mechanics involved in orthodontic treatment is always advancing. Even though there is a correlation between the demand and need for orthodontic treatment⁶, it is often seen that other factors might be responsible for orthodontic demand, instead of the need for treatment. One-third of over 150 people, who presented at the Lagos University Teaching Hospital for orthodontic treatment, did not need treatment⁷. This observation makes it difficult to determine how successful a treatment outcome is, where the objective need for treatment is low. It is therefore important to quantify the amount of

improvement achieved for every orthodontic treatment, including how much overall difference in malocclusion was achieved.

The Aesthetic Component (AC) and Dental Health Component (DHC) of the Index of orthodontic treatment needs (IOTN) are scientific methods of assessing the need for orthodontic treatment, while the Dental Aesthetic Index (DAI) is based on the social standard of dental aesthetics⁸. These indices help to determine patients who require orthodontic treatment and to what extent such care is needed. They however cannot determine the percentage change achieved following orthodontic treatment. Most orthodontic indices put into consideration three main areas: psychosocial limitations, oral function, and the effect on dental health or injury. Other indexes used include the NOTI, the Treatment Priority Index (TPI), and the Handicapping Malocclusion Assessment Record (HMAR).⁹ While the IOTN is mostly used in Great Britain, the NOTI is used by the National Health Insurance System to reimburse the cost of orthodontic treatment.⁹ Despite the difficulties encountered when assessing occlusal relationships and patients' satisfaction with treatment outcomes, the objective assessment of treatment outcomes in orthodontics is very important.¹⁰ Several methods have been proposed to assess orthodontic treatment outcomes, despite being mostly limited to occlusal assessment only.^{11,12,13} The Ideal Tooth Relationship Index (ITRI) was developed to overcome that limitation. However, it involves cumbersome measurements of iatrogenic or photographic changes, as well as skeletal, dental, and soft tissue changes between pre-treatment and post-treatment cephalometric and panoramic radiographs¹⁰.

The Peer Assessment Rating (PAR) Index was designed in 1992 by Richmond S. et al¹⁴ who made a panel of 74 examiners to characterize the degree of orthodontic improvement. The goal was to ensure that objective and quantitative measures are used to

simultaneously assess malocclusion and efficacy of treatment of the same case. The PAR index was designed such that one summarized score is assigned to depict the severity of the malocclusion. The difference in scores assigned before and after treatment recorded on a scoring sheet indicates the extent of improvement in treatment. Opinions differ among orthodontists about what constitutes an improvement in orthodontic treatment, hence, PAR Index provides an avenue for standardization and uniformity in interpreting the outcome.⁹ The index uses the PAR ruler to measure specific components of the treatment outcome, and residual malocclusion is weighted. Orthodontic treatment carried out under high standards is judged by each clinician's mean percentage reduction in weighted PAR score.

As the demand for orthodontic treatment increases in Nigeria, it is important to examine the standard of practice among orthodontists in Nigeria and compare the outcome to other practices abroad. This study aimed to assess the outcome of orthodontic treatment provided at a Nigerian orthodontic training institution, using the PAR index.

Materials and methods

The study was carried out on the study casts, retrieved from the archives of patients who had orthodontic treatment using fixed orthodontic appliance therapy, at the Lagos University Teaching Hospital (LUTH), one of the foremost tertiary referral centres for orthodontic care in Nigeria. Ethical approval was obtained from the Health and Research Ethics Committee (HREC) of LUTH.

Study design: A retrospective cross-sectional study, where a total of 35 study casts were randomly retrieved from the archive of completed cases at the Orthodontics Unit of LUTH. The study was based on the population of orthodontic cases treated by consultant orthodontists and senior orthodontics residents. Subjects were selected according to

specified inclusion and exclusion criteria.

Inclusion criteria for selection:

Cases with complete pretreatment and post-treatment records.

Cases that had documented study models.

Exclusion criteria:

Cases in which treatment was incomplete.

Cases managed with removable appliances.

A simple random sample of study models that met the inclusion criteria was selected. The materials used were the study models, PAR scoring sheets, and the PAR Index ruler. The calibration of the principal investigator for the PAR Index was done by a specialist orthodontist. Selected casts were blinded and randomly scored by the principal investigator using the UK weighting system of PAR Index on both

pre-treatment and post-treatment models. A dedicated PAR Index Ruler was used to increase scoring reliability and ease of measurement. Five out of the 35 measurements were repeated to assess inter-examiner reliability. A total of 43 pairs (pre-treatment and post-treatment) of study casts that met the inclusion and exclusion criteria were retrieved

Statistical analysis: The analysis was done using IBM SPSS 26.0. Descriptive statistics included the calculation of overall mean PAR scores, pre and post-treatment, PAR scores reduction, weighted PAR scores reduction, and mean percentage PAR scores reduction. The Independent sample t-test was used to assess inter-examiner and intra-examiner reliability.

PAR SCORING SHEET

ANT-POST
0 None
1 < 1/2 unit dia
2 = 1/2 unit dia

TRANSVERSE
0 None
1 Xbite band > = 11
2 = 1 tooth in xbite
3 > 1 tooth in xlb
4 > 1 tooth in xlb

VERTICAL
0 None
1 openb 21 > 2mm

CENTRELINE
0 < = 1/4
1 1/4 - 1/2
2 > 1/2

OVERBITE
0 0 - 1/3 openb
1 1/3 - 2/3
2 > 2/3
3 > = FTC
4

CONTACT Pt
0 -
1 -
2 -
3 -
4 -
5 Impacted tooth

THE PAR INDEX
1979
VICTORIA UNIVERSITY OF MANCHESTER

OVERJET
4 > 21 X3
3 11 X3
2 11 X3
1 11 X3
0 0 X3

Name

CASE NUMBER	Pre-Treatment		Date				UN-WEIGHTED TOTAL	WEIGHTED TOTAL
PAR COMPONENTS	RIGHT				LEFT			
Upper anterior segments	3-2	2-1	1-1	1-2	2-3			X1
Lower anterior segments	3-2	2-1	1-1	1-2	2-3			X1
Buccal occlusion	Antero-posterior		Right		Left			X1
	Transverse		Right		Left			X1
	Vertical		Right		Left			X1
Overjet	Positive		Negative					X6
Overbite	Overbite		Openbite					X2
Centre line								X4
TOTAL								

CASE NUMBER	Post-Treatment		Date				UN-WEIGHTED TOTAL	WEIGHTED TOTAL
PAR COMPONENTS	RIGHT				LEFT			
Upper anterior segments	3-2	2-1	1-1	1-2	2-3			X1
Lower anterior segments	3-2	2-1	1-1	1-2	2-3			X1
Buccal occlusion	Antero-posterior		Right		Left			X1
	Transverse		Right		Left			X1
	Vertical		Right		Left			X1
Overjet	Positive		Negative					X6
Overbite	Overbite		Openbite					X2
Centre line								X4
TOTAL								

ASSESSMENT OF OUTCOME

PAR SCORE	IMPROVEMENT
Change in PAR score	Greatly improved
% change in PAR score	Improved
	Worse or no different

Results

The results showed a mean reduction of 15.86 since the mean PAR of subjects' occlusion before treatment reduced significantly from 18.76 to 2.91 after treatment. A mean percentage change of 81.14% indicates a great improvement (70%-100%) in occlusion following orthodontic treatment. (Table 1)

Out of the 43 casts assessed, 31 patients showed great improvement, at a mean percentage reduction of 95%. Five subjects each showed little improvement within the mean percentage reduction range of 44.9%-64.3%, and only 2 showed no improvement at all. The negative mean percentage reduction of the patients who showed no improvement indicates the patient became worse following treatment. (Table 2)

Figure 1 shows a nomogram showing all pre-treatment and post-treatment scores of all study models.

Two subjects who showed no improvement are represented by two dots on the far left of the above nomogram. The middle frame represents subjects who showed improvement following treatment, while all 31 subjects who had great improvement are represented on the far right of the monogram. Each dot represents one participant, except in cases where PAR scores between subjects are the same.

Descriptive Statistics

Table 1: Mean and Standard Deviation

Variables	Mean	SD
Mean Pre-treatment Score	18.76	8.31
Mean Post-Treatment Score	2.91	3.73
Mean Reduction	15.86	9.25
Mean Percentage Change	81.14	27.03

Table 2: Mean percentage reduction in PAR and the category of improvement

Improvement	Number of Patients	Mean Reduction	Mean Percentage Reduction
No Improvement	2	1	-1.39 %
Little Improvement	5	5.6	44.9 %
Improvement	5	13	64.3 %
Great Improvement	31	18.9	95.0 %

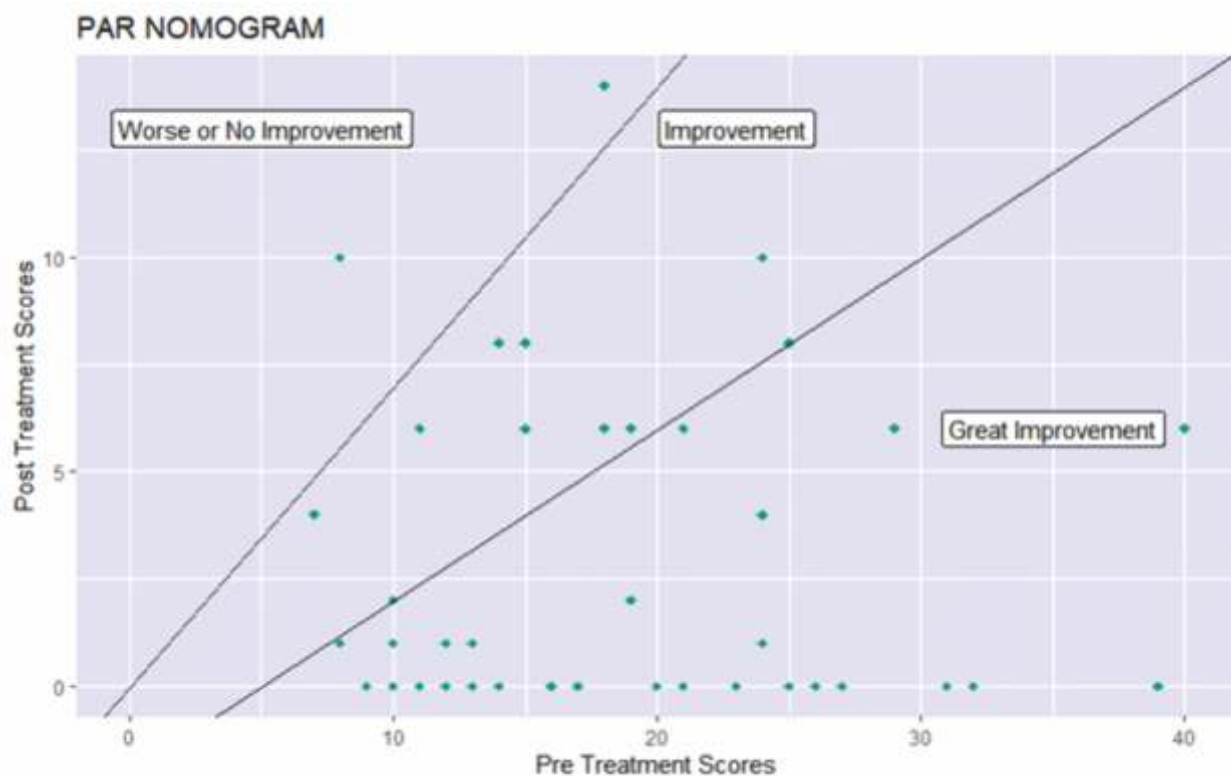


Figure 1: A nomogram showing all pre-treatment scores on the x-axis and post-treatment scores on the y-axis.

Table 3: The number of examined casts with an orthodontic need or optional need for treatment.

Treatment Need	Number of Patients
Treatment Needed	23
Treatment Optional	20

Independent Sample T-test

Group Statistics					
Examiner		N	Mean	Std. Deviation	Std. Error Mean
Pre-treatment Score	1	5	21.60	10.945	4.895
	2	5	26.80	9.338	4.176
Post Treatment score	1	5	0.20	0.447	0.200
	2	5	2.40	3.286	1.470

Independent Samples Test

t-test for Equality of Means

	T	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
						Lower	Upper
Pre-Treatment Score	-0.808	7.806	0.443	-5.200	6.434	-20.102	9.702
Post-Treatment Score	-1.483	8	0.176	-2.200	1.483	-5.620	1.220

The difference between the mean pre-treatment scores of Examiners 1 and 2, was not statistically significant $t(7.806) = -0.808$, $p = 0.443$.

The difference between the mean pre-treatment scores of Examiners 1 and 2, was not statistically significant. $t(8) = -1.483$, $p = 0.176$.

Discussion

Orthodontic graduate institutions all over the world are expected to adhere to standard training ethics. Therefore, a significant improvement in the outcome of treatment is expected. A high standard of treatment is revealed in each case mean percentage reduction in PAR.

This study revealed 72%, 11.6%, and 4.7% of patients managed at the Orthodontics unit of the Lagos University Teaching Hospital showed a mean percentage reduction of 95% in PAR scores (suggesting great improvement), improvement, and no improvement respectively. This percentage is significantly higher than a similar study carried out by Onyeaso and BeGole at an accredited graduate school in the US where the result was 50%, 47%, and 3% suggested great improvement, improvement, and worse or no improvement respectively.¹⁵ Grossly 33% of the PAR scores qualified as greatly improved, according to the criteria of at least a score of 22 cut off for pre-treatment score according to Kerr¹⁶. This is higher than none qualified as great improvement seen

in the study carried out by Onyeaso and BeGole.¹⁵ This difference suggests that more cases managed at LUTH had greater orthodontic treatment needs compared to graduate school in the US. A total of 95.3% of cases studied had improvement in treatment outcome ($>30\%$ PAR reduction). This is also higher than 80% of cases with improvement in a similar study carried out by Adeleke et al at another graduate training institution in Nigeria.¹⁷ In this study, the overall mean pretreatment-weighted PAR score in this study was 18.8, while the mean post-treatment-weighted PAR was 2.9, and the overall mean percentage change was 81.1%. This value is lower than the weighted scores reported by Onyeaso, being 23.83, and a mean percentage reduction of 86%.¹⁵

A random sampling of cases managed with removable or fixed appliances in GDS of England and Wales showed a mean percentage reduction of 55%, which is expected given the limitations of treatment outcomes using removable appliances. The overall mean reduction in this study is close to 82.6% mean percentage reduction in cases evaluated by OD Otuyemi's personal clinical audit of orthodontic

treatment outcomes.¹⁸ However, only 2% of cases examined in this study showed no improvement.

Conclusion

Based on PAR criteria by Richmond,¹⁴ it can be concluded that a high standard of treatment is adhered to in managing orthodontic patients at the Lagos University Teaching Hospital, Nigeria. An overall mean percentage reduction shows the

standard maintained in orthodontic treatment at LUTH is high.

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Digit Sucking Habit: A Review of Literature

Otaren NJ^a, Umweni A.A^a, Otuyemi O.D^b, Ogbeide E^c.

Abstract

Objective: Digit sucking (thumb and finger sucking) is one of the most common forms of non-nutritive sucking. Due to different dentofacial manifestations, it has become of great interest to dentists and specialists in the field.

Methods: This article examined the development and prevalence of the habit, including the dentofacial effects in situations where it is prolonged. The approach to management were highlighted.

Results: Appropriate mode of treatment and timing of treatment should be decided upon, considering the age and level of maturity of the child, severity of malocclusion, psychological status of the child and presence of any other habit, such as tongue thrusting and mouth breathing. No active intervention should be attempted before three years of age due to emotional immaturity of the child.

Conclusion: This article presents a detailed review of the aetiological basis and treatment options in the management of the digit sucking habit.

Key words: Digit sucking, habit.

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Introduction

Sucking behavior in infants and young children are mainly derived from their psychologic need for nutrients. Current understanding of child development suggests that sucking behavior also arises and persists in part because of psychologic needs, as normally developed infants have an inherent biologic drive for sucking.^{1,2,3} This sucking urge can be satisfied through nutritive sucking, including breast and bottle feeding or through non-nutritive sucking on objects such as digits, pacifiers or toys.⁴

Digit sucking (thumb and finger sucking) is one of the most common forms of non-nutritive sucking.^{1,2,5} It is a topic of interest in many fields including psychology, paediatrics, speech therapy and Dentistry.⁶ Due to different dentofacial manifestations, the digit sucking habit has become of great interest to dentists and specialists in the field.^{6,7}

At birth, non-nutritive sucking is related to rooting and sucking reflexes (up to 12 months of age).^{6,8} Up to the age of 2 to 3 years, sucking is considered a normal developmental response.^{9,10,11,12} After this, it is considered a learned habit.^{1,8} The habit is considered prolonged when it is continued up to the age of 7 years and beyond.^{6,13} In a previous study,⁴ digit sucking at fourty eight months and beyond is considered prolonged. Although it is mostly believed that sucking habit begins as an adaptive response which eventually becomes a learned habit, there still exists some evidence in the minority of patients that prolonged sucking habit is maintained by some underlying psychological or emotional disturbances.^{3,11}

Prevalence of Digit Sucking Habit

The prevalence of digit sucking habits in children has been suggested to vary from one population to another, with reports of prevalence ranging from 8% to 23%¹⁴⁻¹⁹, and between 2% and 23% in Nigerian children.^{15,20,21} As many as 19% of children in the United States of America continue the habit after their 5th birthday.²² Prevalence rate is 17% among Indian children²³ and 30% among Swedish children.²³ A low prevalence rate of 1% is observed in Eskimo children.²³

Isiekwe²⁰ in 1984 carried out a study on thumb-sucking habit in a group of 10-15 year old children in Lagos, Nigeria and results showed a prevalence of 2.1%. Nnachetta²⁴ conducted a similar study among 6-12 year old school children in Lagos State, Nigeria and recorded a prevalence of 24.3%, which was the most common habit recorded. Quashi-Williams²¹ reported a prevalence of digit sucking as 44.2% in 4-5 year old children in Eti-Osa local government area of Lagos State, Nigeria. Onyeaso and Sote²⁵ carried out a study on the prevalence of oral habits in Lagos and Ibadan, Nigeria. The sample consisted of 563 pre-school children aged 3-5 years. Results from the study showed prevalence of oral habit was 13.14%, digit sucking was 10.66% (5.86% in males and 4.86% in females).

Uwaezuoke et al¹⁸ carried out a prospective cross-sectional study on 100 pre-school children under 5 years old in Enugu, Eastern Nigeria. Results showed a prevalence of digit sucking of 23% with a slight male preponderance. Onyeaso¹⁵ carried out a study among primary schools from different parts of Ibadan, Nigeria. The study consisted of 493 school children aged 7-10 years old. Results showed that 49 (9.9%) indulged in oral habits, prevalence of digit sucking was 40(8.1%), males 21(52.5%), females 19 (47.5%). More males indulged in digit sucking, though it was not statistically significant ($P>0.05$).

Kerosuo²⁶ reported the prevalence of sucking habits in an African group (Tanzanians) as 10%, Asian/Arab

group as 4% while it was 10% among Finnish children. Pacifier sucking was much more common (77%) than digit sucking (6%) in Finnish children, and girls were slightly more often digit suckers (9%) than boys (4%). Ngom et al²⁷ carried out a study on 443 Senegalese children aged 5-6 years. The aim of the study was to determine the prevalence and factors associated with non-nutritive sucking behavior. Information on the feeding patterns of the children when they were infants was breast feeding, bottle feeding, or a combination of both. Results indicated a prevalence of 16.5 % and 17.2 % respectively for digit and pacifier sucking. Omer et al²⁸ carried out a study among 489 pre-school Sudanese children, 3-5 years old. Prevalence of oral habits was 30.3 %, thumb sucking was the most prevalent at 56 (11.5 %). No significant associations were found between oral habits, age, and gender. The study conducted by Larsson²⁹ on the prevalence of digit-sucking habits among 415 Zimbabwean children aged 1-2 years showed digit sucking as 2% and dummy sucking as 0%.

Another study on sucking habits was carried out by Farsi and Salaman¹⁷ among 583 Saudi children aged 3-5 years. The prevalence of sucking habits was 48.36%, where dummy sucking was the dominant habit at 37.90% while digit sucking was 10.46%. Kharbanda et al³⁰ also carried out a study on oral habits among school children in Delhi, Northern India, 5554 children aged 5-13 years were assessed. Results showed prevalence of oral habits as 25.5%, but digit sucking was relatively less common (0.7 %). There was no significant difference between boys and girls in prevalence of oral habits, digit sucking was more common in girls (1.0 %) compared to boys (0.4 %), and was statistically significant ($P<0.001$).

Furthermore, Bliss³¹ carried out a study in New Zealand on the prevalence of digit sucking among 300 2-4 year olds and results showed a prevalence of digit sucking of 17%, while prevalence of dummy sucking was not recorded. Zadik¹⁴ conducted a study on the prevalence of digit sucking among 333 Israeli

children from birth to 7 years old. Results showed the prevalence of digit sucking as 23% and dummy sucking, 70%.

Bishara et al⁴ carried out a prospective cohort study on changes in the prevalence of nonnutritive sucking patterns in the first 8 years of life among children in Iowa, United States of America. The objectives of the study was to determine prospectively the duration of nonnutritive sucking behaviours of children between 1 and 8 years of age and the effects of persistent habits on selected occlusal characteristics in the late primary dentition. Sucking behaviour data were initially collected from 797 children who were followed longitudinally from birth through a periodic questionnaire completed by their parents. In addition, study models were obtained for 372 children at 4 to 5 years of age and assessed for posterior crossbite, anterior open bite, and overjet. The subjects were grouped according to the duration and type of habit (pacifier or digit), for less than 12 months or more than 48 months. Children with nonnutritive sucking of less than 12 months were further grouped according to the duration of breastfeeding.

Results showed there was a significant ($P=0.001$) decrease in the incidence of pacifier habits between 1 and 5 years, from 40% to 1%. There was a significant ($P=0.01$) decrease in the incidence of digit habits between 1 and 4 years of age, from 31% to 21%. Between 4 and 7 years of age, the decrease in the incidence continued, but at a slower rate. Between 7 and 8 years of age, there was an additional significant ($P=0.008$) decrease in the incidence of digit habits, but 4% of the children were, to various extents still sucking fingers. Children who had pacifier or digit habits lasting less than 12 months did not have significantly different occlusal characteristics than children who were breast-fed for 6 to 12 months.

Prolonged pacifier and digit habits caused significant change in the occlusal characteristics in the late primary dentition, and the effects of pacifiers were different from those of digit sucking. Children with

prolonged sucking habits had significantly greater anterior open bites and posterior crossbites, and excessive overjets, but had the same incidence of class II canine relationships as children with minimal habits. There was significantly ($P=0.044$) greater incidence of posterior crossbites in children with pacifier habits ≥ 4 years (41.7 %) than those with digit habits (15.2 %). The incidence of excessive overjets (≥ 4.0 mm) was significantly ($P=0.012$) greater in children with digit habits (39.1 %) than in those with pacifier habits (0 %), incidence of anterior open bites and class II canine relationships were not significantly different between the two groups.⁴

Tricia et al³² studied 156 children aged 4 to 16 years in Trinidad. There was a high prevalence of oral habits (91.6 %) with 63.9 % having two or more habits. Oral habits, such as pacifier use, digit sucking, tongue sucking, lip biting and sucking, nail biting, and object chewing were recorded. The most common oral habit was nail biting (52.9 %) and ice crunching was most commonly found in females. Tongue sucking was predominant in children of African ethnicity.

Aetiology/Predisposing Factors in Digit Sucking Habit

Digit sucking is defined as placement of the thumb or one or more fingers in varying depths into the mouth. Thumb and finger sucking is one of the commonly seen habits that most children indulge in. Thumb and finger sucking may be practiced even during intrauterine life. The presence of this habit is considered quite normal till the age of $3\frac{1}{2}$ to 4 years. Persistence of the habit beyond this age can lead to various malocclusions.⁷

The cause of oral habits is not fully understood, but various theories have been put forward.^{10,21} Controversies prevail in the origin of sucking habits, the two most important being the psychoanalytic theory of Freud and the learned habit theory.¹⁰ Various psychosocial factors such as age, sex, social class, infant feeding pattern as well as stress factors such as

parental belovedness, overprotection, strictness and negligence have been associated especially with digit suckers.³³

A shorter duration of breast-feeding can predispose to digit sucking since breast-feeding fosters close maternal and child bonding, as well as emotional satisfaction for both mother and child.^{23,34} It has been reported that bottle-feeding is a major predisposing factor.¹ The severity of displacement of the teeth and investing tissues depends on the trident conditioning factors.^{35,37} Duration is the amount of time spent on sucking, the longer the duration of each sucking period, the greater the damage. Frequency of indulgence is the number of times the habit is practiced. Frequent and continuous sucking is more damaging than occasional, short time practice. Amount of force is the force exerted on the teeth while practicing the habit, the more the force applied, the greater the damage.

A number of theories have been put forward to explain why thumb and finger sucking occurs.³⁵ Freudian theory was proposed by Sigmund Freud in the early part of the 19th century. He suggested that a child passes through various distinct phases of psychological development of which the oral and anal phases manifest in the first three years of life. In the oral phase, the mouth is believed to be an oro-erotic zone. The child has the tendency to place his/her fingers or any other object into the oral cavity. Prevention of such an act is believed to result in emotional insecurity and poses the risk of the child diversifying into other habits.

The oral drive theory of Sears and Wise of 1950 proposed that prolonged nursing (breast feeding) could lead to thumb and finger sucking.³⁵ Benjamin suggested in his theory that thumb and finger sucking arises from the rooting or placing reflex seen in all mammalian infants.⁷ Rooting reflex is the movement of the infant's head and tongue towards an object touching his cheek. The object is usually the mother's breast but may also be a finger or pacifier. This rooting reflex disappears in normal infants around 7

to 8 months of age.³⁵ Psychological aspects is a theory which suggests that children deprived of parental love, care, and affection are believed to resort to this habit due to a feeling of insecurity. Learned pattern theory suggests that thumb/finger sucking is merely a learned pattern with no underlying cause or psychological bearing.³⁵

Phases of Development of Digit Sucking Habit

An infant is born with some elementary reflexes whose pattern and order are inherited. Sucking is an innate reflex in humans. On the other hand, a habit whose pattern and order are acquired develops from constant repetition of the act. Lateral tongue thrusting habit develops due to extraction space in the posterior segment.^{35,36} At the beginning, the infant makes an effort through frequent learning and practice, later on, the muscles start responding more readily. It has been observed that the unconscious pattern of a habit develops in response to five sources namely, instinct, insufficient/incorrect outlet of energy, pain or discomfort, abnormal physical size of anatomic parts, imitation of/imposition by parents or others.^{35,36}

The phases of development of digit sucking habit have been described.^{35,36} Phase I (Normal and Sub-clinically significant) is the first phase seen during the first three years of life. The presence of thumb/digit sucking during this phase is considered quite normal and usually terminates at the end of phase I. Phase II (Clinically significant, sucking) is the second phase and extends between 3 to 6^{1/2} years of age. The presence of sucking during this period is an indication that the child is under anxiety. Treatment to solve these dental problems should be initiated during this phase. Phase III (intractable sucking) is the third phase and suggests that any thumb/finger sucking persisting at this phase is a symptom of a more significant problem than that associated with malocclusion. A psychologist may have to be consulted during this phase.³⁵

Effects of Prolonged Thumb and Finger Sucking

There is considerable controversy regarding the potential deleterious effects of thumb and finger sucking and their treatment modalities.^{9,37-38} However, most agree that if the habit is discontinued well before the permanent incisors erupt, no residual damage to the alignment or occlusion of the teeth is likely to result.^{9,38} In the first 3 to 4 years of life, the damage to the occlusion is largely confined to the anterior segment. This damage is usually temporary, provided the child starts with a normal occlusion. Following the cessation of the habit, there is generally some spontaneous correction in the form of reduction in open bite and maxillary incisor proclination. The extent to which malocclusion self-corrects varies and depends on the age of the patient at the time of habit cessation, as well as the severity of the malocclusion resulting from the habit. Due to emotional immaturity of the child under four years of age, in most cases, it is advisable to intercept the habit between the age of four years and eruption of permanent incisors at ages 6 to 7 years.^{9,37-38} The severity of displacement of the teeth and investing tissues depends on the trident conditioning factors, duration, frequency of indulgence and intensity of force.^{9,34,35,37,38}

Apart from these conditioning factors, the type of malocclusion produced also depends on a number of variables which includes, the position of the digit in the mouth, associated orofacial muscle contractions, mandibular position during sucking, and facial skeletal pattern.^{9,37-38} Prolonged digit sucking can produce effects on the maxilla, mandible, interarch relationship, lip placement and function, tongue placement and function, and other effects.³⁸

Effects on the Maxilla

Proclination of upper anteriors occurs because during the habit, a finger is placed at an angle such that a labial and apical force is applied on the maxillary incisors, producing a pronounced labial flare. The

effects are increased maxillary arch length, anterior placement of the maxillary apical base, increased SNA angle, increased clinical crown length of maxillary incisors, counter-clockwise rotation of the occlusal plane, and decreased palatal arch width/constriction of maxillary arch. Constricted maxillary arch occurs due to lowering of the tongue and increased activity of the buccinators muscle during sucking which creates an imbalance between the pressure of the tongue and cheek, thus causing constriction of the maxilla with a “V”-shaped palate. Other effects on the maxillae include; increased risk of trauma to the maxillary incisors due to their proclination and atypical root resorption of primary central incisors.³⁸

Effects on the Mandible

The main effect of thumb and finger sucking on the mandible is the retroclination of mandibular incisors. The lower incisors are often used for fulcrum/leverage by applying a lingual and apical forces on them, thus causing their retroclination. Another effect on the mandible is decreased SNB angle.³⁸ Narrow mandibular widths and reduced mandibular molar arch depth have been reported.⁷

Effects on Inter-Arch Relationship

Some of the effects the habit of thumb and finger sucking has on the inter-arch relationship include an increased overjet, which is due to the flaring of the upper incisors and retroclination of the lower incisors, decreased overbite, and anterior open bite.³⁹ Anterior open bite is caused by a combination of the following factors; interference of normal incisor eruption by the interposed thumb, excessive eruption of the posterior teeth due to separation of the jaws, and opening up the bite further.¹⁰⁰

Similarly, posterior crossbite occurs as a consequence of maxillary arch constriction. The force exerted by the cheek muscles on the maxilla is not balanced by the tongue musculature due to lowered tongue posture, thus resulting in maxillary constriction.

While there is no restriction of mandibular growth, this eventually leads to bilateral posterior crossbite and increased chances of developing class II molar and canine relationship³⁹.

Moore et al⁴¹ carried out a study on a species of monkeys, the study was designed to assess the influence of digit sucking on growth, development, the morphology of dental and facial skeletal structures, and to evaluate the mechanism of changes associated with cessation of digit sucking. Changes in the dentofacial structures of four *Macaca mulatta* monkeys with non-nutritive digit sucking habits (as a result of maternal deprivation) were evaluated through the use of serial cephalometric radiographs with metallic implants and histologic studies with *in vivo* bone markers.

Control data for cephalometric comparison were obtained from the studies of facial growth in normal rhesus monkeys by Erickson⁴⁰ and Pihl.⁴¹ Two *M. mulatta* specimens with ages comparable to the experimental animals served as histologic controls. The monkeys were aged 42 to 54 months or the equivalent of 13 to 17 years of human growth. The investigation was conducted in two stages of 94 and 70 days respectively to permit observation of the effects of continued digit sucking (animal A-stage 1; animal B-stages 1 and 2); cessation of digit sucking (animal C-stage 1 and 2; animal D-stage 1); resumption of sucking after a period of non-sucking (animal D-stage 2), and the effects of restraining procedures (animal A-stage 2).

Tantalum implant markers for serial cephalometric analysis were placed on the left side of the facial skeleton of each animal under thiopental (Pentothal Sodium) anaesthesia through a nonsurgical technique modified after Bjork. Cephalometric radiographs were made before the experimental period and at the end of stages 1 and 2. Tracings of successive lateral radiographs were superimposed on the middle and anterior cranial base landmarks to assess the positional changes of maxilla and mandible, relative to the cranial base. Superimposition of metallic

implant images was used to assess shape changes and anteroposterior tooth movement within the maxilla and mandible. Oxytetracycline and Procion dyes were used as *in vivo*-bone markers during the experiment. At the conclusion of stage 2, the animals were killed and perfused with 10% formalin.

After fixation, tissue was selected from the fronto-maxillary, pterygo-maxillary and premaxillo-maxillary sutures for histologic examination. Tissue blocks in the left side of the head were used for undecalcified sections. They were embedded in bioplastic, machine cut into 150 μ sections, hand ground to 50 μ to 60 μ , and viewed under ultraviolet light. Blocks from the right were decalcified and selective sections were prepared with hematoxylin and eosin, Mallory's connective tissue stain, and Verhoeff's stain. Other sections were deparaffinised to permit examination for procion under ultraviolet light. Visual observation during the experimental period revealed that continuation of the digit sucking habit resulted in maintenance of anterior open bite (animal B), whereas cessation of the sucking habit resulted in bite closure (animal C-stage 1 and 2; animal D-stage 1). Reinstitution of the sucking habit after cessation resulted in the reopening of the anterior open bite (animal D-stage 2). Comparable observations were made from superimposed cephalometric tracings.

The maintenance of anterior open bite with continued sucking is in sharp contrast to the anterior bite closure observed with cessation of the sucking habit. With continued cessation of the sucking habit, the direction and amount of forward maxillary and mandibular growth and tooth movement were similar to those changes observed in the control animal. With cessation of digit sucking, the maxilla was found to have rotated in a downward and backward direction. This, in conjunction with rotation of the premaxilla and maxillary incisor teeth, resulted in closure of the open bite. Concomitant downward and backward mandibular movement paralleled rotation of the premaxillo-maxillary complex. Changes in the

mandibular dentition were not considered to be distinguishable from those in the control animal. Histologic study of midfacial articulations confirmed the clinical and radiographic observations. With continued sucking, successive tetracycline marks on the premaxillary side of the premaxillo-maxillary suture indicated a pattern of bone deposition consistent with forward adjustment of the premaxilla relative to the maxilla.

In contrast, with cessation of sucking, no mineralization was observed along either premaxillary or maxillary suture margins. Adjacent sections stained with hematoxylin and eosin showed evidence of resorptive remodeling along both suture borders. Tetracycline markings in the preparation of the pterygomaxillary region of digit-sucking animals showed that mineralisation had occurred along the posterior aspect of the maxillary tuberosity and along the anterior surface of the pterygoid process. This suggested anterior displacement of the entire maxillary process, relative to the pterygoid plates. During non-sucking periods, the interruption of tetracycline markers within the pterygoid process and the lack of tetracycline uptake along the periosteal surface of the tuberosity were indicative of posterior maxillary movement. It is apparent from this study that digit sucking has significant effects on the growth pattern and resultant facial morphology of the *M. mullata*. During the sucking period, the facial skeleton grew in a generally forward direction. After cessation of the habit, there was a downward and backward rotation of the maxillary complex, accomplished by compensatory adjustments in the circum-maxillary suture system. The presence of the premaxillo-maxilla suture permitted the adaptation of the premaxilla. Closure of the open bite took place primarily by this independent premaxillary movement. In humans, self-correction of open bite malocclusion after cessation of digit sucking is more likely to take place by adaptive changes in tooth position because of lack of patency of the premaxillo-maxilla suture. The study concluded that cessation of digit sucking resulted in closure of the open bite through downward and backward rotation of the maxillary complex.

Significant remodeling in the maxillary tuberosity-ptyergoid plate region indicated that digit sucking has more far-reaching effects than has been reported previously.^{40,41} Diouf et al⁴² carried out a study on 226 Senegalese children aged 5-6 years. The aim of the study was to determine the influence of the mode of nutritive and non-nutritive sucking on the dimension of primary dental arches. Results showed that children who had enjoyed mixed feeding (breast/bottle combination) had longer lengths of anterior maxillary arch and significantly deeper of the palatal arches, than children receiving breast alone. The children with antecedents or a current non-nutritive sucking habit had a longer anterior maxillary arch than subjects with no non-nutritive sucking habit ($P=0.01$). Regarding inter-arch relationship, the children with antecedents or a current digit-sucking habit had reduced overbite than their peers who had no non-nutritive sucking habit ($P=0.04$).

Effects on Lip Placement and Function

On the lip placement and function, the effects of thumb and finger sucking include lip incompetence, short, and hypotonic upper lip. Here, the upper lip is passive during swallowing. Other effects are hyperactive lower lip which occurs due to hyperactive mentalis activity during swallowing. Puckering of the chin can be noted, lower lip placement is lingual to upper anteriors, marked mentalis contraction which causes sealing of lower lip lingual to upper anteriors, rather than labially, during swallowing. Another effect is that the lower lip contacts the lingual surface of upper anteriors with some force, thus accentuating the upper anterior proclination and overjet.³⁸

Effects on Tongue Placement and Function

During thumb and finger sucking habit, the effect on tongue placement and function includes lowered posture of the tongue, increased chances of developing tongue thrust in which lack of lip seal and flaring of upper anteriors often causes the development of compensatory tongue thrust in order to create a partial vacuum required during the swallowing act.³⁸

Other Effects

These includes, risk to psychological health, deformation of the offending digit, speech defects (lisping) due to increased overjet and anterior open bite.³⁸

Prolonged or chronic digit or pacifier sucking may predispose to dental conditions such as dental caries¹⁰⁵ and malocclusion,^{17,38,44} and is associated with acute otitis media⁴⁵ and with some psychological disorders, including depression as well as colic.⁴⁶⁻⁴⁸ It is also associated with self-mutilating behaviour, for example hair pulling, which leads to alopecia (hair loss).⁴⁹

Diagnosis of Digit Sucking Habit

The parents should be questioned on the frequency and duration of the habit. The child's emotional status should be assessed by enquiring into such things as; feeding habits, parental care of the child, whether the parents are employed. An intraoral clinical examination should record all the features seen, such as proclination and open bite. The child's fingers should be examined. The presence of clean nails with callus on the fingers is commonly associated with thumb and finger sucking.^{9,35}

Management of Digit Sucking Habit

A wide range of treatment modalities have been used in the management of thumb and finger-sucking habits. An appropriate mode of treatment and timing of treatment should be decided upon, keeping with the age and level of maturity of the child, severity of malocclusion, psychological status of the child and presence of any other habit, such as tongue thrusting, mouth breathing.³⁸ No active intervention should be attempted before age 3 years due to emotional immaturity of the child.⁷ Most children discontinue the habit by 4-5 years of age.³⁸ In most cases, it is advisable to initiate the treatment for prolonged digit-sucking habit between the age of 4 to 5 years and the eruption of the permanent incisors.³⁵ Generally, malocclusion is self-corrected if the habit is stopped before the eruption of permanent incisors.³⁵ Before attempting treatment, the patient should express a desire to stop the habit.

Without patient cooperation, treatment of digit-sucking habit may not be successful. When indicated, habit breaking appliances should act as reminders encouraging the patient to stop the habit, rather than punishing the child.³⁷ Cooperation of the parents and an understanding of potential consequences of prolonged habit is also important.⁶ Parents should be advised not to rebuke or criticize the child, which will only aggravate the problem. Positive reinforcement and encouragement of the child is recommended.^{9,38} In the presence of a psychological problem associated with digit sucking habit, psychological consultation and necessary management are recommended before appliance therapy.^{9,38}

The management of thumb/finger sucking habits include: psychological approach, mechanical aids, chemical approach.

Psychological Approach

It is usually said that children lacking parental care, love and affection resort to this habit. Thus the parents should be counseled to provide the child with adequate love and affection. The parents should also be advised to divert the child's attention to other things such as play and toys. The success of any habit-interception procedure largely depends upon the subject's cooperation and willingness to be helped to discontinue his/her sucking habit. Thus, the parents and the dentist should seek to motivate the child. Dunlop put forward a theory called "Beta hypothesis" which states that the best way to break a habit is by its conscious, purposeful repetition.³⁵ He suggested that the child should be asked to suck his/her thumb/finger observing himself/herself as he/she indulges in the habit. This procedure is very effective if the child is asked to do the same at a time when he/she is involved in an enjoyable activity.³⁵

Mechanical Aids

These basically are reminding appliances that assist a child who is willing to quit the habit but is not able to do so as the habit has entered a subconscious level. These appliances usually consist of a crib placed

palatal to the maxillary incisors. Habit breakers can be of two types; removable habit breakers which are passive removable appliances that consist of a crib anchored to the oral cavity by means of clasps on the posterior teeth, and fixed habit breakers made of heavy gauge stainless steel wire that can be designed to form a frame soldered to bands on the molars. Other aids that can be used to intercept the habit include bandaging the digit or bandaging the elbow.³⁵

Chemical Approach

The use of bitter tasting or foul smelling preparations placed on the digit that is sucked can make the habit

distasteful. The medicaments that can be used include, pepper dissolved in a volatile medium and quinine.^{9,35}

Conclusion

This article presents a detailed review of the aetiological basis, clinical effects, treatment options and management of the digit sucking habit.

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Using Multiple-Choice Questions (MCQs) as an Effective Assessment Method in Postgraduate Orthodontic Education in Nigeria: A Review Article

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Abstract

Introduction: Multiple choice questions (MCQs) have been effectively utilized as an assessment method in postgraduate medical and dental education. The main objective of this article was to review MCQs in the medical education literature, with the aim to suggest concepts and theories that can be applied to enhance the use and effectiveness of MCQs in postgraduate orthodontic education in Nigeria.

Methods: An extensive review of the medical education literature was conducted to highlight the reasons for using MCQs as an assessment method in medical education. In addition, there was a review of different assessment frameworks that can be used to enhance learning by using MCQs. The Part I examination in Dental Surgery of the National Postgraduate Medical College of Nigeria, was used as a case-study for this purpose. The different concepts highlighted from the literature were applied to describe how the quality of learning and assessment with MCQs in the Part I Dental Surgery examination, can be improved upon.

Results: A review of the literature showed that MCQs can be used to test higher levels of knowledge and clinical reasoning. Assessment frameworks such as Millard's theory and Learning Oriented Assessment were also used to highlight different ways of enhancing the quality of assessment and the learning opportunities that can be created from the use of MCQs, using the Part I examination of the NPMCN as a case study. The review also highlighted effective principles to take into consideration in designing and setting good quality MCQs.

Conclusion: MCQs can be effectively utilized as an assessment tool to facilitate learning in postgraduate dental education. The Part I examination in Dental surgery has been used as a case study to describe how MCQs can be used to facilitate assessment and learning at higher levels of clinical reasoning, while also focussing on the right principles to design very good MCQs.

Keywords: MCQs, Post-graduate orthodontic education, Nigeria

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Introduction

Multiple choice questions (MCQs) are widely utilized in the assessment of students in medical education.¹ This article discusses how the use of

multiple-choice questions (MCQs) can support learning, teaching, and preparation for practice for dental residents in Nigeria, using the Part 1 professional examination in dental surgery of the National Postgraduate Medical College of Nigeria (NPMCN) as a reference point. Orthodontics is one of the dental specialties in which the residents are assessed, in the Part I professional examination using MCQs.

Postgraduate dental training in Nigeria and the Part 1 professional (summative) examination: Postgraduate dental training in Nigeria is coordinated by the NPMCN. The residency training programme is a 6-year programme. The curriculum of the NPMCN is competency based and divides the residency training into two parts. The first part of the training coincides with the first three years, during which residents rotate through different dental specialties, after which they write the Part I examination. The Part 1

examination is a summative assessment, which means that it is an assessment of learning and a high-stake examination. Successful candidates in this examination become Senior Registrars in their respective dental specialties. The MCQs in the Part I examination are administered via a computer-based test, with all candidates from across the country taking the examination on the same day. The MCQ examination is used to screen the candidates who can proceed to the second aspect of the Part 1 examination, which includes essays, orals and OSCE assessments.

MCQs can be divided into two families: those that require test takers to indicate all responses that are appropriate (true-false), and those that require test takers to indicate a single, most accurate response (one-best-answer).^{1,2} The type of MCQ used in this proposal is the single best answer question. This has been reported to be more accurate compared to the 'True-false' response, as these question types are better able to assess application of knowledge, integration, synthesis, and judgment.^{1,2}

One of the main reasons for choosing MCQs is the fact that well-constructed MCQs can be used to test application of knowledge, problem-solving skills, and clinical reasoning.²⁻⁴ Furthermore, MCQs provide a relatively cost-effective assessment and objective format for assessment.^{2,3} This is particularly important bearing in mind that the environment in which I work is resource limited. However, one of the areas in which the cost effectiveness of MCQs may sometimes be questioned, is the huge time demands required for setting good questions, particularly for inexperienced examiners.⁴ However, it is also important to bear in mind that other types of assessment formats such as OSCEs may also be time demanding to construct. In addition to this, computer based MCQs have proven to be very efficient and significantly reduce the time for marking and collation of results, and the burden associated with testing large student cohorts.⁵

Purpose of assessment in dental education

Assessment drives learning⁶, however, a fundamental challenge is to stimulate the right kind of learning.⁷ According to Boud (2000), assessments have the 'double duty' of both grading the students and facilitating learning.⁸ In addition, assessments are expected to be rigorous but not exclusive, authentic yet reliable, exacting while also being fair and equitable, to adhere to long-established standards while reflecting and adapting to contemporary needs,

and at the same time, accommodate the expectations not only of academics, their students, and the university in which both are engaged, but also of government and government bodies.⁹

Several advantages of using MCQs as an assessment format in medical education have been cited in the literature.² One of these is that it provides an objective and efficient means of assessment through its numerous sampling opportunities. In addition, it allows for consistent scoring by ensuring a correct or single best answer which is chosen a priori (from theoretical deduction) and allows for consistent marking by either human markers or with the aid of computer technology.^{2,5} Some studies have also reported that performance in high-stakes examinations comprised mainly of MCQs have been shown to predict certain clinical practice outcomes.^{2,10,11}

Multiple choice questions present with some limitations and disadvantages. One of the often-cited criticisms of MCQs is that they may be restricted to the assessment of lower-level cognitive abilities because they promote memorisation and factual recall and do not encourage (or test for) high-level cognitive processes and abilities.^{5,12,13} However, some researchers such as Nicol (2007) and Pugh et al. (2019) have argued that this depends on how the tests are constructed and that well-constructed MCQs can actually be used to test higher levels of knowledge and clinical reasoning. A second argument against MCQs is that they provide very limited room for feedback and thus do not allow for personalized feedback based on the students' needs. In addition to this, students often have very limited roles in setting the goals and standards for MCQs and are often unable to clarify questions during the test.⁵ Thus, it is argued that this form of assessment does not allow for active student participation in the assessment process⁸ or allow students to develop the skills needed to self-regulate their own learning.^{14,15} Self-regulated learning simply refers to students' ability to regulate their own learning.¹⁴

The following paragraphs describe how different assessment frameworks can be used to enhance learning using MCQs, while overcoming some of the limitations of MCQs highlighted above and how they can be used to improve the quality of MCQ assessment in the Part 1 professional examination.

1. Miller's Pyramid: In 1990, Miller¹⁶ described the Millers pyramid - an assessment framework for medical education in which he described four different levels of

assessment; with the base of the pyramid assessing knowledge, ('knows'), the next level assessing competence ('knows how to use the knowledge'), the second level assessing performance ('shows how to use the knowledge') and the highest-level assessing action ('does').¹⁶ Miller further stated that while it may be reasonable to assume that either action or performance implies the achievement of the more basic aspects of the pyramid, conversely, measurement of the infrastructure (knowledge and competence) cannot be said to predict fully and with confidence, the achievement of the more complex goals.¹⁶

In addition to Miller's pyramid, Bloom's taxonomy of educational objectives is also used as a guide.¹⁷ Bloom described a framework for assessing educational goals, consisting of six major categorising factors; knowledge (at the base), comprehension, application, analysis, synthesis, and evaluation particularly with respect to Orthodontics. Thus, in designing MCQs for the Part 1 examination, the aim will be to design questions that will address the higher levels of Miller's pyramid and Bloom's taxonomy such as analysis, synthesis, and evaluation. Therefore, a greater emphasis will be placed on questions that test clinical application of the basic orthodontic knowledge of the candidates.

2. Learning Oriented Assessment: This is an assessment framework that focuses on learning as the major goal of assessment and was described by Carless.⁷ The main aim of LOA is to strengthen the learning aspects of the assessment, which can be achieved through formative (assessment for learning) or summative assessment, provided the central focus is on engineering appropriate student learning. LOA emphasizes that once the assessment task embodies the desired learning outcomes, the students are primed for deep learning experiences by progressing towards these outcomes.⁷ The learning outcomes describe the major competencies expected of the students at the end of a course. The three main elements of LOA are assessment tasks as learning tasks, students' involvement in assessment as peer-or self-educators, and feedback as feedforward. Further explanation will be provided on the latter two in subsequent paragraphs as they also overlap with the learning assessment framework described by Nicol.⁵

In the context of the Part I examination, it is important that the learning outcomes are clearly stated in the residents' handbook. This handbook also contains the curriculum for the residency programme in Nigeria

and is given to each resident at the commencement of training. The learning outcomes enumerated should consistently form the core for the design and content of the MCQs to be used in the Part 1 examination. Furthermore, these MCQs should test real-life clinical scenarios of the orthodontic knowledge and skills outlined in the course handbook.

3. Students' involvement in assessment and feedback: Nicol (2007) argued that the development of a proper assessment framework may be used to facilitate active student participation and self-regulation in the use of MCQs as an assessment format.⁵ It is interesting to note that this framework also describes the latter two principles of LOA which are students' participation in assessment and feedback. This framework highlights the fact that the power of MCQs to enhance learning is not dependent only on proper test construction, but also by manipulating the context in which these texts are used to enhance feedback, increase student participation, and enhance self-regulation. Nicol and MacFarlane-Dick (2006) described seven principles of good feedback practice that will support the development of learner self-regulation, thus promoting assessment for learning. These principles include the fact that to self-regulate their own learning, students should have a good understanding of what is required in the assessment tasks; secondly, they emphasize the power of dialogue in learning through group interaction, peer feedback and discussion; third, self-regulation requires motivation and a belief that effort will yield results.⁵ It is important to note that feedback in itself will not promote learning¹⁸, rather, timeliness and prompt student engagement are key factors to success.⁷

In the context of the Part 1 examination, one of the ways to improve on students' participation in the assessment process is by introducing an MCQ setting exercise during the revision course for the examination. The revision course takes place three months before the examination and is organized for all candidates preparing for the Part I examination. The candidates may be divided into different groups of six each and each group asked to design 5 MCQ questions based on the topics revised during the course, with reference to Orthodontics. The groups should be given a guide on setting MCQs using Miller's pyramid to ensure that only questions that assess higher levels are included. The questions developed by each group are then presented to the rest of the Class and vetted for quality during the

Class presentation. This process will enable the students to play an active role in formulating the questions, selecting the correct answers, and providing feedback for the selected questions. In addition, it will be done as part of a group exercise, thus allowing peer feedback, and the students also get personalized feedback during the class-review of the questions. Some of these questions will ultimately become included in the summative assessment examination either in their original form or with some modifications. This exercise will help to increase motivation and self-belief. The entire exercise, with the early feedback, will help to facilitate learning and hopefully improve the performance of the students in the summative Part 1 MCQ examination.

Design of MCQS

Van der Vleuten (1996) described a conceptual model for assessing the utility of assessment methods. In this model, the utility (U) of an assessment is described as a multiplicative function of the reliability (R), validity (V), educational impact (E), acceptability (A) and Cost (C), with differential weights (w) accorded to each of them. This model will be used as a guide in this study to design the MCQs in orthodontics for the Part I examination. In doing this, a greater weighting will be given to reliability and validity as these are very important for proper design of the MCQs as a summative assessment.

A. Reliability: This is a measure of the reproducibility or consistency of a test.²⁰ A wide sampling of content across the area of interest allows for stable and reproducible scores. This can easily be achieved with MCQs by increasing the number of questions set or to be answered per unit time, and increasing the duration of the exam (Van der Vleuten, 1996). Reliability can also be increased by adding a wide variety of subtests.²¹

Implementation: The exam will consist of 200 MCQ questions, with a duration of three-hours. This will help to increase the reliability of the test. In addition, apart from the MCQs, other assessment tests such as OSCEs and oral examinations will also be used to assess the candidates during the Part 1 examination, to increase the reliability of the results. The OSCEs will be used to assess communication skills and practical clinical skills in orthodontics, which cannot be assessed with MCQs.

B. Validity: This pertains to whether a test measures the competency it is supposed to measure.⁴

i. Ensuring the questions assess clinical application and problem-solving skills related to the learning outcomes for junior residency training: Miller's pyramid¹⁶ and Bloom's taxonomy¹⁷, will both be used as expatiated in the previous section. The 'Key feature approach' will be used in setting questions. This approach assesses examinees' ability to apply their knowledge and make critical decisions at specific decision points. (Page et al., 1995) This requires examiners to focus on the critical steps in the resolution of a problem before they begin question formulation and can be effectively used in MCQs.²

ii. Quality of the MCQs Questions:

a. Use of Context rich questions: Context-rich questions refer to questions which include a clinical vignette accompanied by one or more questions.² A clinical vignette is an abridged report of a patient summarizing any relevant history, clinical findings, investigations data and treatment. Studies have shown that examinees use clinical reasoning when answering these questions.^{23,24} However, it is important that the information presented in the vignette is required to answer the question correctly, and not just included as a 'window dressing'. This will ensure that the questions test for application of knowledge and clinical reasoning.²

b. Avoiding technical flaws: Each MCQ should pass the 'cover-test', which means that the answer to each question can be provided without looking at the options. (Van der Vleuten, 1996). In addition, technical item flaws i.e flaws related to 'irrelevant difficulty' and 'test wiseness' should be avoided.¹ Flaws related to 'irrelevant difficulty' include: options that are overtly long and complicated; non-homogenous and using 'none of the above' as an option. Flaws related to 'test wiseness' include: grammatical cues where options don't follow from the stem; using absolute terms such as 'always' or 'never' and where the correct answer is more specific and longer than the other options.¹ The 'cuing effect' described by Van der Vleuten, (1996) in which the options guide the candidate to select the correct answer, will also be avoided.

iii. A review process for the questions: Validity is strongly enhanced when the test material is scrutinised by a review process.¹⁹

iv. **Score Validity, Standard setting, and Item analysis:** Once the item scores are valid, the total score will be valid. The final score for the examination will be 100%. There will be no negative marking. The pass-mark for the examination will be determined by standard setting, using a criterion referenced method-the Modified Angoff method. Standard setting is the process of determining the minimum pass-level in an examination.²⁶ The Modified Angoff method deals with the desirable competency level that each student should achieve and uses the borderline student as a reference for defining the pass score. Item analysis, including an assessment of the difficulty and discrimination index for each question, should be conducted after the examination.

Implementation: All the examiners involved in the Part 1 examination will undergo a two-day online training on how to set very good context-rich MCQs. A panel of judges consisting of subject experts will sit two months before the examination to scrutinize all the questions for the examination to ensure they are of high quality as outlined above. This panel will also carry out the standard setting for the MCQs and determine the pass-mark using the criterion reference method referenced above. The panel will also be trained on how to carry out standard settings.

C. Educational impact: The educational impact of the test will be greatly increased if the MCQs are directly related to the learning objectives. This has been well expatiated under Learning Oriented Assessment.

D. Acceptability: The test acceptability is closely linked to fairness. Fairness in assessment in this examination has been positively affected by all the

design choices listed above. Two other key factors include location of assessment and feedback. The examination will be conducted in different locations in Nigeria via computer-based testing. Acceptability to the examiners is also very important and will be enhanced by training. Candidates who do not pass the current examination will be able to sit for the examination again in six months and have multiple attempts at passing the examination.

E. Cost: The use of MCQs presents a very cost-effective assessment format as discussed earlier in this presentation.

Conclusion

In conclusion, MCQs can be effectively deployed to assess higher levels of knowledge and clinical reasoning, using the Part I examination in Dental Surgery in orthodontics as a reference point. In addition, they can be used to drive learning by placing emphasis on improved student self-regulation and enhanced feedback. This review has also presented details on the proper design of good MCQs, while laying emphasis on a high level of reliability and validity in making the design choices to create high quality MCQs. Ultimately, the design and use of high quality MCQs in orthodontics assessment in postgraduate education in Nigeria, will positively influence the quality of training in orthodontics in the country.

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The Non-Surgical Treatment of a Patient with a Class III Malocclusion and Anterior Open Bite Complicated by Mandibular Lateral Displacement (MLD) with the use of the Multiloop Edgewise Archwire (MEAW): A Case Report

Amoah KG^a, Newman-Nartey M^a

Abstract

A case of an 18 year old who presented with a class III malocclusion, anterior open bite and mandibular lateral deviation who was successfully treated using the multiloop edgewise archwire (MEAW) mechanics with the extractions of all third molars. She was treated using 0.018X0.030 MBT brackets and the MEAW was constructed with 0.016X0.022 blue elgiloy wire. Total active treatment time was 19 months followed by six months of passive treatment without archwires

Keywords: Multiloop edgewise archwire (MEAW), class III malocclusion, anterior open bite

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Introduction

Mandibular lateral deviation (MLD) is quite a common occurrence in patients with malocclusion and may present with mild to very severe deviations. MLD is characterized by deviation of the mandible to one side, deviation of the chin from the facial midline, posterior crossbite, and may also involve facial asymmetry¹ and internal derangement of the temporomandibular joint². The etiology of anterior open bite (AOB) has been attributed to a combination of genetic and environmental factors^{3,4}. According to

Kim, AOBs may manifest with divergent maxillary and mandibular occlusal planes and mesial angulation of posterior teeth, together with increased vertical dimensions⁵.

MLDs and open bites are challenging malocclusions which can be difficult to treat orthodontically because of the adaptations in the soft tissues and skeletal frame. The multiloop edgewise archwire (MEAW) appliance, which was first described by professor Kim Young-Ho in 1967, initially for the treatment of anterior open bites, can now be used to treat all types of malocclusions including complex ones thanks to further development of the technique by Sadao Sato who evolved the theory of posterior discrepancy in the development of malocclusions.

The use of MEAW requires patient compliance with the use of elastics continuously. A systematic review by Tabancis et al. revealed that MEAW shows appreciable stability in the long term⁶.

Case report

An 18-year-old female presented with complaints of inability to chew properly and to bring her teeth together. Examination showed the patient with a class III malocclusion on a mild skeletal class 3 base, 3mm anterior open bite, -5mm overjet and a 2mm mandibular lateral deviation to the right. The patient's facial proportions were increased and her profile was mildly prognathic.

Intraorally, on the right side, the molar relationship was class III (or super class I) with some occlusal contact between the upper and lower first molars. The premolars and canines were all in full class III.

On the left side the canines, premolars, and first molars were in full class III with no occlusal contact between the first molars on that side, as a result of the shift of the mandible to the right. The molars were also in an edge to edge relationship, signifying a crossbite tendency.

The maxillary canines in the maxilla were distally angulated. In the lower arch, there was a 2mm hypoplastic patch on the mesiobuccal surface of tooth no 44. There were plaque deposits on the teeth in the lower labial segment and a Panoramic x-ray showed mesial angulation of posterior teeth.

Cephalometric analysis was performed using the denture frame analysis. Ricketts' analysis was also used to augment the findings. The analyses confirmed a skeletal class III with increased vertical proportions



Treatment objectives were:

- 1) Alignment and leveling of the teeth and establishing a normal functional occlusion with normal overjet and overbite
- 2) Correction of the molar and canine relationships to class I
- 3) Correction of the mandibular lateral deviation
- 4) Correction of posterior crossbite tendency on the left side
- 5) Referral for composite veneering of tooth 44 after orthodontic treatment

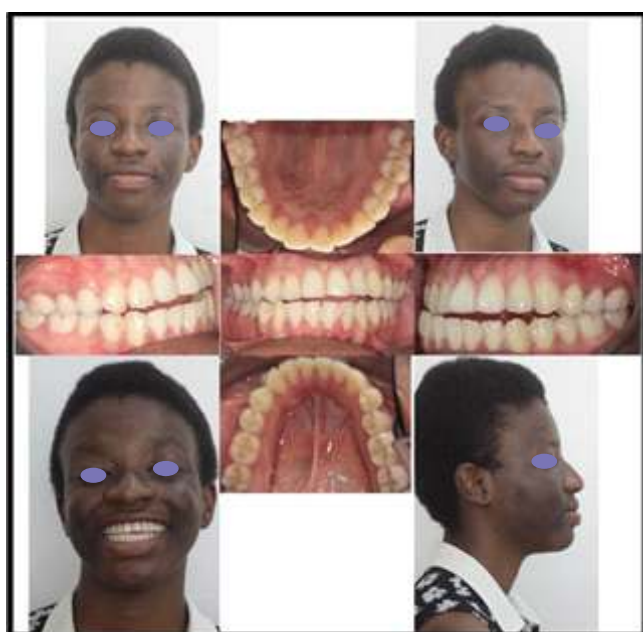
The MEAW was the method chosen for achieving the above objectives due to the author's experience in the use of the treatment approach. Treatment plan involved the extraction of all 3rd molars and the use of 0.018X0.030 MBT equilibrium II brackets (Dentaurum Germany).

After explanation of treatment and signing of consent forms, brackets were placed on all the teeth. Bands with convertible tubes were placed on all first molars and tubes were placed on all the second molars.

Treatment progress

The initial archwires placed in both arches were 0.016 heat activated nickel titanium to level and align the teeth. Over the course of the next two visits all the 3rd molars were extracted under local anaesthesia.

Six months later impressions were taken for the fabrication of the customized multiloop wires and 0.016 stainless steel wires were placed in both arches. The MEAW was bent with 0.016X0.022 blue elgiloy wire (rocky mountain orthodontics). The wires were heat treated at 500°C for 10 minutes before insertion at her next visit.



The MEAW wires were inserted after 8 months. 15° tip back bends were placed in the wires starting from the 3rd loop. The tip back bends were slightly increased on the left side to help with the repositioning of the mandible and correction of the centre line.

3/16 heavy short (6OZ) elastics were attached from the first loop in the lower arch to the second loop in

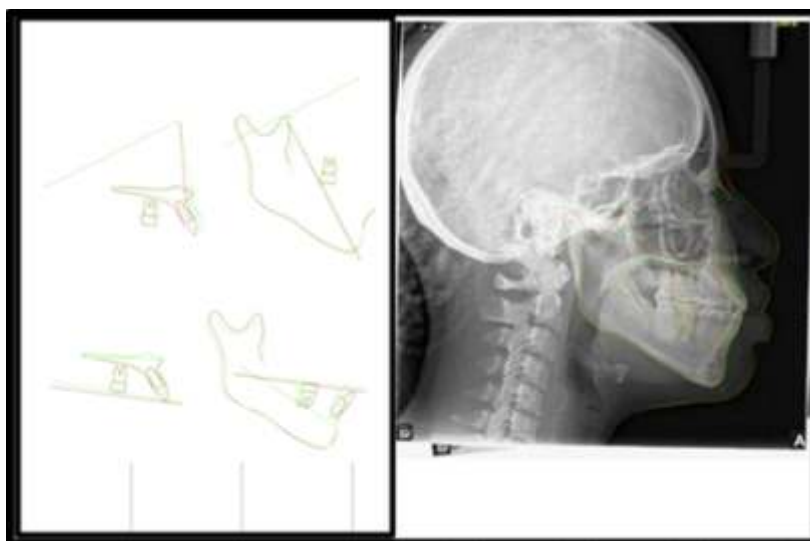
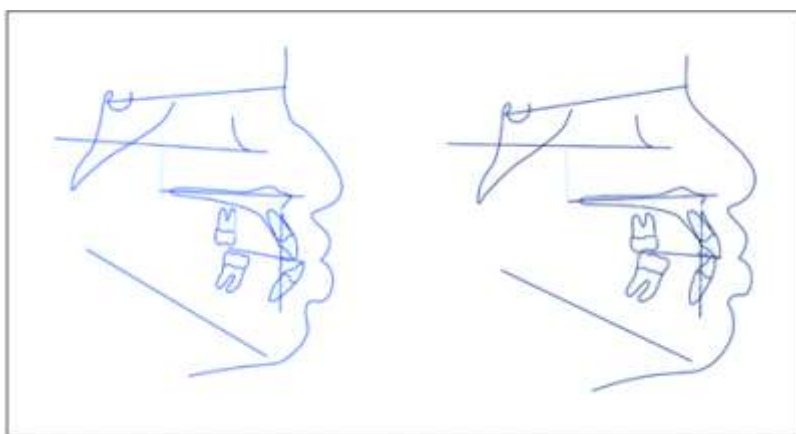
the upper arch. The elastics were worn full time and changed everyday. After maximum intercuspation, positive overjet and overbite had been achieved, the wires were removed and all the teeth were undertied. The patient was observed for a further 6 months in this state to check for stability of overbite and mandibular deviation correction before the braces were finally taken off. The overall active treatment time was 19 months.

After debonding, Hawley retainers were prescribed for night-time wear.



Table 1: Pre- and Post treatment cephalometric analysis

Measurement	Pretreatment	Post treatment
ODI°	60	65
APDI°	92	87
CF°	150	149
FMA°	28	26
Lower facial height°	42	43



Treatment results

The assessment of the treatment outcome showed that all the major objectives were achieved. These changes were augmented by slight counterclockwise rotation of the mandible with a decrease in FMA by 2°. The APDI decreased by 5° and the ODI also increased by 5°. The lower facial height however increased minimally as evidenced by 1° changes in the combination factor (CF) and lower facial height. The panoramic x-ray and lateral cephalograms showed uprighting of the mesially tipped teeth.

Discussion

Constructing a functional occlusion is a very important challenge underlying orthodontic treatment. Studies have shown that changes in the vertical dimensions of posterior teeth and occlusal plane to a large extent influence the growth of the mandible. Thus unusual changes in the vertical dimension and cant of the occlusal plane during growth equally can contribute to the development of malocclusions(7, 8) The underlying concept of the MEAW philosophy is based on the hypothesis that selective changes in the inclination of the occlusal plane can compensate various types of malocclusions by utilizing the adaptability of the temporomandibular joint(9). The MEAW is able to control the individual position of each tooth through

the application of gentle and uniform forces. Challenging cases as seen in this case report can be treated effectively by MEAW as an alternative to invasive orthognathic surgery. Extensive skeletal deficiencies cannot be eliminated, however it (MEAW) causes change through dentoalveolar compensation(10). One advantage of the MEAW concept is the avoidance of premolar extractions due to its several mechanical properties. For a successful outcome however, this requires patient compliance with the wear of the elastics. Successful outcomes In this case was achieved mainly through uprighting of the mesially inclined teeth, reconstructing of the maxillary occlusal plane with the aid of MEAW followed by the adaptation of the mandible

Conclusion

The successful treatment of this malocclusion shows that the MEAW is a very effective method of treating skeletal malocclusions without resorting to orthognathic surgery and extractions of premolars.

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Transmigration And Ectopic Eruption of A Mandibular Canine: A Review and Case Report.

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Abstract

Transmigration is a rare phenomenon in canines, it is however rarer for a transmigrant canine to avoid impaction. From the orthodontic perspective, the above case could be described as a unique yet uncomplicated one. The occlusal, aesthetic and functional discrepancies and effects of the transmigration do not warrant great treatment need nor prolonged orthodontic treatment.

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Introduction

Unerrupted teeth have been reported to migrate from their original positions and predispose to malocclusion. However, these changes in position are usually restricted to the same quadrant of the dental arch; the only exception being the canine which is the only tooth to have been reported to migrate across the midline¹. The term 'transmigration' was first used by Ando et al in 1971 to describe the movement of an unerupted mandibular canine across the midline²⁻⁴. This definition was modified by Javid⁵ to include cases where more than half of the mandibular canine had crossed the midline. The first reported case of transmigration involving any other tooth apart from the mandibular canine was presented by Aydin and Yilmaz⁶ in 2003 when they reported a case of transmigration of a left maxillary impacted canine. Before this, transmigration had only been reported in the mandible. Pre-eruptive migration of a tooth across the midline by more than half its length would therefore appear to be a more accurate definition of transmigration⁶⁻⁸.

The actual movement of the mandibular canines across the midline may be challenging to positively prove in many cases due to late or adult presentation, however, there have been cases where evidence has shown this to have occurred. Tarsitano et al² reported cases of transmigration of mandibular canines where there was an attempt at extraction following inferior alveolar nerve blocks to the located sides of the transmigrated canines. The authors reported that pain was produced until inferior alveolar nerve blocks were administered in the contralateral side where the canines originated showing evidence of contralateral innervation of the transmigrant canines. More convincing evidence was provided by Ando et al⁹ who in 1964 reported a case of transmigration of an unerupted mandibular canine in a school boy after radiological monitoring with serial radiographs over 8 years which showed the migration of the canine from the left body of the mandible across the symphysis to a final position beneath the right mental foramen. According to Wertz³, three important criteria of transmigration may include a missing contralateral canine, contralateral nerve supply and the transmigrated tooth being a mirror image of its contralateral counterpart.

Transmigration is a rare occurrence with only 137 reported cases in the literature as of the beginning of the 21st century.⁶ The incidence of transmigration has been reported to have a range of 0.1% to 0.31% compared with an incidence range of 0.92% to 5.1% for mandibular canine impaction.⁷ The majority of transmigrated canines remain impacted however eruption of these teeth in their new sites have been reported mostly erupting labially or buccally and occasionally they have been found to erupt in the line of the arch in between incisors or as supplemental canines¹. The introduction of the orthopantomograph radiograph as a routine screening tool in dentistry has contributed to the increased diagnosis and reporting of cases of transmigration and indeed other asymptomatic dento-skeletal anomalies¹

Of the 117 transmigrant mandibular canines studied in the work of Joshi¹⁰, approximately 9% occurred bilaterally while the left mandibular canine showed a slightly higher incidence of transmigration with about 57%. There was also a higher incidence (65%) reported among females. The majority of the transmigrant mandibular canines reviewed in the study remained impacted (89%) with only 11% erupting. Of the erupted transmigrant mandibular canines which were 12 in number, seven erupted labially, three erupted on the dental arch and one erupted in a lingual position. There was one case of extra-oral eruption of an inverted transmigrant canine through the right side of the chin¹⁰.

Mupparapu¹¹ described 5 different patterns of transmigration based on the inclination of the long axis of the canine, the relationship of the canine crown with the midline, adjacent teeth and the contralateral erupted canine at the time of diagnosis. Type 1 pattern was found to be most common (45.6%) where the canine was positioned mesio-angularly across the midline labial or lingual to the incisors within the jawbone; type 2 pattern presented with a horizontally lying impacted canine below the apices of the incisors in 20% of studied cases; type 3 pattern occurred in 17% of cases where the transmigrant canines erupted either mesial or distal to the contralateral canine; type 4 patterns which had the transmigrant canines impacted horizontally beneath

the apices of contralateral premolars or molars occurred in 14% of cases while type 5 was the least common (1.5%) and had the transmigrant canine vertically positioned in the midline with the long axis crossing the midline irrespective of eruption status¹¹.

The most common treatment of transmigrant canines is extraction which may frequently require a trans-alveolar approach due to impaction or ectopic location³. Following extraction, orthodontic correction of midline discrepancies and/or spacing can be carried out for improved aesthetics and intercuspation.

We present a case of transmigration with the ectopic eruption of a right mandibular permanent canine as a supplemental tooth in the left mandibular quadrant.

Case Report

A case is described of a 24-year-old lady who presented to the orthodontic clinic due to aesthetic concerns as a result of an extra tooth in the lower left anterior region which had erupted 3 years earlier. There was no history of previous dental extractions, neither was there a history of systemic illness or conditions of any known kind and she was found to be fit on general physical examination.

Extra-oral examination revealed a convex profile with a class 1 skeletal relationship and a transversely symmetrical face with competent lips (Fig. 1).

On intra-oral examination, there were no gross soft tissue abnormalities and the maxillary arch had a full complement of dentition. The mandible presented with bilateral mandibular tori and an asymmetric dental arch. The right mandibular quadrant showed the absence of the canine while the left mandibular quadrant displayed severe crowding as a result of a supernumerary canine located labial to the left mandibular lateral incisor and mesial to the left mandibular canine. The cusp tip of the supplemental canine was just below the level of the mid-cervical area of the left mandibular lateral incisor (Fig. 1).

Other occlusal features include mild spacing in the right mandibular quadrant (2mm distal to the right mandibular lateral incisor) lingual displacement and mesio-lingual rotation of the left mandibular second premolar and mild crowding of the maxillary anterior segment with disto-labially rotated central incisors. Inter-arch relationships include bilateral Angle's

class I molar relationship and class II incisal relationship (overjet of 8mm measured at the distal aspect of the upper central incisors), deep bite and a 3mm lower midline shift to the right (Fig. 1).

Radiological investigations confirmed the anatomical resemblance of the supernumerary tooth to a canine tooth on a periapical radiograph (Fig. 3) and the absence of a canine in the right mandibular

quadrant on an orthopantomograph (Fig. 2).

A treatment plan of extraction of the transmigrant mandibular canine followed by fixed orthodontic appliance treatment for correction of intra-arch and inter-arch discrepancies was proposed.

Records and investigations



Fig. 1 Photographs (facial, intra-oral)



Fig. 2 Panoramic radiograph



Fig. 3 Periapical radiograph

Discussion

The clinical diagnosis of transmigrant mandibular right canine made in this case is based on the clinical and radiological evidence of a missing canine in the right mandibular quadrant and the presence of an erupted supernumerary canine in the left mandibular quadrant. In the absence of conclusive evidence of actual movement of a mandibular canine from one quadrant to the adjacent, the absence of a contralateral canine, mirror image presentation of two canines in the same quadrant and the demonstration of contralateral nerve supply were the 3 criteria were proposed by Wertz³ to prove transmigration. In this case, the mandibular right canine is absent however the two canines in the left quadrant appear to be identical images and not mirror images of each other (Fig. 1). The presence of contralateral innervation in this case unfortunately can only be investigated at the time of extraction of the transmigrant canine.

This case of transmigration in a female patient involving the right mandibular canine is consistent with the reports of Buyukkurt⁴ and Joshi¹⁰ on the higher incidence of transmigration among female patients however this may be due to the higher proportion of females among orthodontic patients. Joshi¹⁰ however found the left mandibular canine more frequently transmigrant (occurring in 57% of reported cases) contrary to our finding in this case. Among mandibular canines, transmigration was found to occur about 9-16 times less frequently than impaction and only less than 20% of transmigrant mandibular canines managed to erupt⁷. In this case,

the transmigrant right mandibular canine has erupted in a position mesio-labial to the left mandibular canine. This corresponds to a type-3 pattern of transmigration according to Mupparapu¹² which described a transmigrant canine that has erupted into the oral cavity in a position mesial or distal to the contralateral canine. This pattern was reported to be the most common among transmigrant canines which erupted into the oral cavity^{11, 12}. The transmigrant mandibular canines when they manage to erupt, have also been found mostly in labial positions on the dental arch (58%), with only about 8% incidence of lingual eruption¹⁰.

Conclusion

Transmigration is a rare phenomenon frequently necessitating significantly invasive and complicated surgical intervention because a majority of transmigrant canines remain impacted in ectopic positions often closely related to roots and apices of other teeth. In the reported case, the unlikely event of an eruption of the transmigrant canine without significant aesthetic and functional occlusal challenges has made this unique case straightforward and uncomplicated in terms of treatment.

Authors' contribution - Contributions equally made by all the authors

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Conflict of interest - Nil

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Acknowledgements

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Appendix 1:

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