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Original Article

Dentistry Section

A Clinical Measurement of Supraeruption in Unopposed Posterior Teeth in Kheda Population: A Cross-sectional Observational Study

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ABSTRACT

Introduction: Supraeruption causes an interruption in occlusal harmony, hampers speech, disrupts masticatory patterns and complicates subsequent restorative dentistry. Despite its clinical significance, there is limited literature quantifying the extent of supraeruption in unopposed posterior teeth. This gap hinders early diagnosis and timely intervention. Therefore, it is important to raise awareness regarding the prevalence, consequences, preventive measures and management of supraeruption to support evidence-based treatment planning and improve long-term oral health outcomes.

Aim: To clinically measure the extent of supraeruption in unopposed posterior teeth in Kheda population using a standardised photographic method and to evaluate its association with variables such as the duration of edentulism, age groups and arch location.

Materials and Methods: This cross-sectional observational study was conducted in the Department of Prosthodontics, Crown and Bridgework and Oral Implantology at the Faculty of Dental Science, Dharmsinh Desai University, Nadiad, Gujarat, India, from July 2023 to September 2023. Patients who reported to the outpatient department were screened based on selection criteria by the principal investigator. Demographic information such as the patients' age group, years since tooth extraction and cause of tooth loss were recorded. Patients with unopposed posterior teeth, with at least a canine and second molar present, who gave written informed consent were included in the study. A total of 81 patients were selected and diagnostic impressions of the arch with unopposed posterior teeth were made, followed by pouring casts. Images of the casts were captured using a standardised photographic setup. The extent of supraeruption was measured using Adobe Photoshop software. Statistical analyses included the Shapiro-Wilk test, unpaired t-test, Analysis of Variance (ANOVA) with post-hoc test and chi-square (χ^2) test, with $p \leq 0.05$ considered significant.

Results: The variable assessed was the extent of supraeruption over the period of edentulism. The mean±Standard Deviation (SD) of tooth loss for durations of 1-5 years, 6-10 years and 11-15 years were 1.27±0.46, 2.48±0.41 and 3.22±0.19, respectively. The data revealed a statistically significant correlation between mean supraeruption ratios and the duration of edentulism.

Conclusion: The study concluded that unopposed posterior teeth contributed significantly to supraeruption, with a higher prevalence in the maxillary arch. Moreover, there was a notable difference in the mean ratios of supraeruption based on the duration of edentulism.

Keywords: Dental occlusion, Edentulous, Jaw, Molar, Partially, Tooth loss

INTRODUCTION

Oral health is a vital component of general health and well-being. Oral diseases remain among the primary challenges faced by society, including dental caries, periodontal disease, tooth loss, oral cancer, oro-dental trauma and birth defects such as cleft lip and palate. The phenomenon of missing teeth develops for various reasons, including genetic conditions, injury, trauma, tooth decay, poor nutrition, detrimental oral habits and inadequate oral hygiene. If not replaced in a timely manner, these issues can lead to malalignment of opposing or adjacent teeth.

People often prioritise the replacement of teeth in the anterior region for aesthetic reasons over posterior teeth. Since the loss of posterior teeth does not immediately impact function and aesthetics, their replacement is frequently considered less necessary. Mandibular molars are often the first to be lost and rehabilitation in this area tends to be ignored for extended periods. This neglect can lead to modifications in occlusion, such as pathological migration of teeth, deep bite, supraeruption, drifting, open contacts and food lodgement in adjacent teeth [1,2].

Supraeruption can be described as the phenomenon where a tooth erupts into an opposing edentulous area beyond the occlusal plane. In the initial years following tooth removal, there is an excessive amount of active supraeruption. Loss of periodontal support may become noticeable in later years, leading to passive eruption of the tooth [3]. This altered alignment may expose the root surface, increasing the risk of gingival recession, which results in aesthetic concerns, tooth sensitivity and a heightened susceptibility to root surface caries. Pockets may form between the affected tooth and its neighboring teeth, leading to inflammation and periodontal disease [4].

The study utilises a novel, reproducible approach to measure the degree of supraeruption using digital photographs of casts analysed via Adobe Photoshop software. This method offers a reliable, non invasive, low-cost and easily accessible alternative to radiographic or direct intraoral measurement techniques.

There is inadequate literature correlating the magnitude of supraeruption to the duration of edentulism. Therefore, The present study aimed to digitally quantify and evaluate the extent of supraeruption in unopposed posterior teeth in Kheda population using study casts, examine its association with the implicated arch and determine whether there is a correlation between supraeruption and various age groups.

The digital method enabled precise measurement of supraeruption in relation to the duration of edentulism. It is of significant concern for

dentists to have knowledge of supraeruption, as this understanding would lead to improved comprehension of prosthodontic rehabilitation.

MATERIALS AND METHODS

A cross-sectional observational study was conducted in the Department of Prosthodontics, Crown and Bridgework and Oral Implantology, Faculty of Dental Science, Dharmsinh Desai University, Nadiad, Gujarat, India, from July 2023 to September 2023. Ethical clearance was obtained from the Ethics Committee, Faculty of Dental Science, Dharmsinh Desai University (FDS/DDU/EC/19/2023).

The subjects provided written and verbal consent for their participation after being briefed on the intent of the study and the procedures involved.

Sample size calculation: The required sample size of 81 participants was calculated using G*Power software.

Inclusion and Exclusion criteria: Participants of any gender, aged between 21 and 65 years, with natural permanent teeth and two or more fully unopposed posterior teeth, including at least a canine and a second molar, were included in the study. Exclusion criteria included participants with a history of prosthodontic treatment, orthodontic treatment, congenital or acquired defects, as well as those who had undergone orthognathic reconstructive surgery.

Study Procedure

Demographic information such as participants' age group, years since tooth extraction, and cause of tooth loss were recorded. Impressions of the arch with unopposed teeth in the posterior region were made using irreversible hydrocolloid impression material (Zhermack, Tropicalgin, Dentsply India Pvt. Ltd.) [Table/Fig-1] and casts were created with Type IV dental stone (Kalstone, Kalabhai Karson Pvt. Ltd., India) [Table/Fig-2] [5].

[Table/Fig-1]: Irreversible hydrocolloid impression material.

[Table/Fig-2]: Die stone - Type 4 gypsum product.

An image of the cast was captured using a digital camera (Canon EOS 200D 24.1 Megapixel DSLR, Canon Inc., Tokyo, Japan) [Table/Fig-3] with a macro lens (f=100mm/F2.8, Tokina Inc., Tokyo, Japan) [Table/Fig-4]. The camera was stabilised with a tripod at a distance of 50 cm, ensuring that the occlusal surface was parallel to the tabletop and the buccal aspect of the supraerupted tooth was aligned parallel to the lens.

[Table/Fig-3]: Canon EOS Megapixel DSLR.

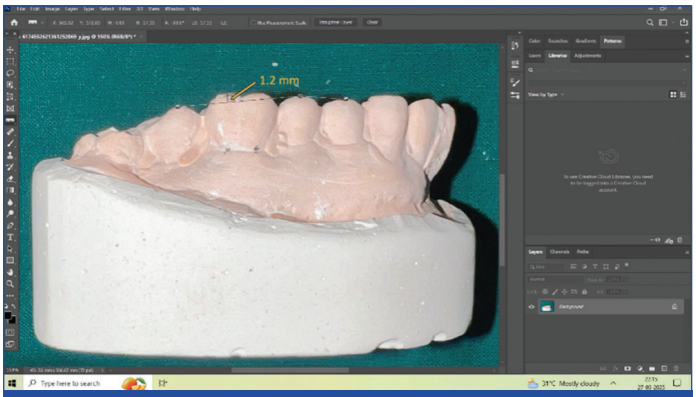
[Table/Fig-4]: Macro lens.

The photos were transferred to a computer and the extent of supraeruption was measured using Adobe Photoshop software (version 21.2.2) [Table/Fig-5] [5,6]. A digital vernier calliper (Showa Precision Tools Co., Ltd., Japan) [Table/Fig-6] was employed to measure the height of the supraerupted tooth. The extent of supraeruption was assessed using a combined digital imaging and measurement technique. Initially, two reference points were marked at the cervical margin and the cusp tip and the vertical height of the supraerupted tooth was measured directly on the cast using a digital vernier calliper.

[Table/Fig-5]: Adobe photoshop software [5,6].

[Table/Fig-6]: Digital vernier calliper.

Standardised photographs of the dental casts were captured using a DSLR camera. These images were subsequently analysed using Adobe Photoshop software. The same reference points were measured in pixels within the software and these pixel values were calibrated against millimeter measurements obtained from the cast. A spline curve was established, extending from the tip of the canine to the buccal cusps of the terminal tooth, intentionally excluding the supraerupted teeth during curve construction. Using the ruler tool, a perpendicular line was drawn from the curve to the highest point of the supraerupted tooth. The resulting distance, representing the amount of supraeruption, was measured in pixels and converted to millimetres within the software. This method was employed to quantify the extent of supraeruption for each participant [Table/Fig-7] [5,6].



[Table/Fig-7]: Measurement of supraerupted tooth [5,6].

STATISTICAL ANALYSIS

The normality assumption was tested using the Shapiro-Wilk test. Two continuous sites—maxillary and mandibular—were compared using an unpaired t-test. Three continuous groups, categorised by the years since tooth loss (1-5 years, 6-10 years and 11-15 years), were compared using ANOVA with a post-hoc test. Categorical groups were compared using the Chi-square (χ^2) test. Probabilities of less than 0.05 and 0.001 were considered statistically significant and highly significant, respectively.

RESULTS

In the data collected, the mean±SD of tooth loss for the periods of 1-5 years, 6-10 years and 11-15 years were 1.27±0.46, 2.48±0.41 and 3.22±0.19, respectively [Table/Fig-8]. The minimum and maximum values for these periods were (0.46, 2.32), (2.0, 3.45) and (3.03, 3.50), respectively. This table, based on the Shapiro-Wilk test, demonstrates that mean supraeruption progressively increases with the duration of edentulism.

Based on the One-way ANOVA test [Table/Fig-9], there was a statistically significant difference in supraeruption among the three groups with different durations of tooth loss. Post-hoc analysis [Table/Fig-10] revealed significant pair-wise differences in supraeruption among all three duration groups (1-5 years, 6-10 years and 11-15 years), confirming the progressive nature of supraeruption over time (p<0.05). The unpaired t-test [Table/Fig-11] indicated that mean supraeruption was significantly higher in the maxilla (1.85±0.77 mm) compared to the mandible (1.38±0.83 mm), with a statistically significant p-value of 0.029.

Years since tooth loss	n	Mean±SD	Confidence Interval (CI) (95%)		Minimum	Maximum
			Lower Bound	Upper Bound		
1-5 Years	53	1.27±0.46	1.15	1.40	0.46	2.32
6-10 Years	22	2.48±0.41	2.30	2.67	2.00	3.45
11-15 Years	6	3.22±0.19	3.01	3.42	3.03	3.50
Total	81	1.74±0.80	1.57	1.92	0.46	3.50

[Table/Fig-8]: Descriptive statistics of supraeruption (in mm).
Test applied: Descriptive statistics. SD: Standard Deviation; N: Number of subjects

Parameters	Sum of squares	DF	Mean square	F	p-value
Between groups	36.72	2	18.36	96.63	p<0.001
Within groups	14.76	78	0.19		
Total	51.48	80			

[Table/Fig-9]: Comparison of supraeruption (in mm) among the three groups of different durations of tooth loss.
Test applied: One-way ANOVA. Df = Degrees of freedom. A statistically significant consider p<0.001)

Group (I)	Group (J)	Mean difference (I-J)	p-value
1-5 year	6-10 year	-1.21	p<0.001
	11-15 year	-1.95	p<0.001
6-10 year	1-5 year	1.21	p<0.001
	11-15 year	-0.74	p<0.001
11-15 year	1-5 year	1.95	p<0.001
	6-10 year	0.74	p<0.001

[Table/Fig-10]: Tukey HSD post-hoc test for multiple comparisons.
Test applied: Tukey HSD (Honestly Significant Difference) post-hoc test, p<0.001 considered statistically significant

Site	n	Mean±SD	Mean Difference	t	p-value
Maxilla	63	1.85±0.77	0.47	0.029	0.029
Mandible	18	1.38±0.83			

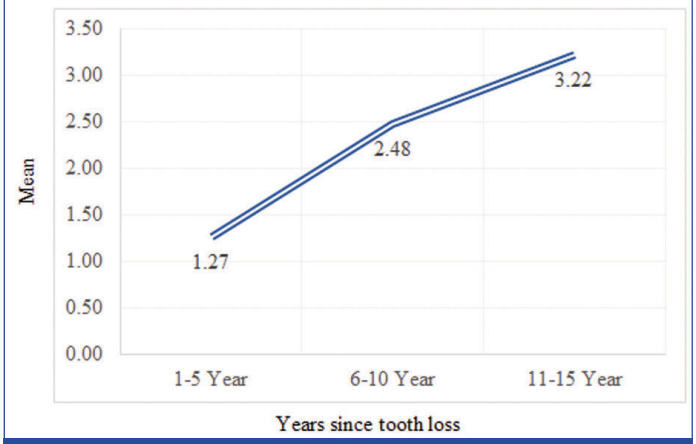
[Table/Fig-11]: Unpaired t-test for supraeruption (in mm) with respect to site.
Test applied: Unpaired t-test. SD: Standard deviation; N: Number of subjects. A statistically significant consider p<0.05

Based on the Chi-square (χ^2) test [Table/Fig-12], no significant correlation was found between the site of supraeruption and the number of years since tooth loss (p=0.292). [Table/Fig-13] consolidates mean supraeruption data, highlighting a clear upward trend with increasing duration of edentulism.

Site	Years since tooth loss			Chi-square	p-value
	1-5 year	6-10 year	11-15 year		
Maxilla	39	18	6	2.461	0.292
Mandible	14	4	0		

[Table/Fig-12]: Chi-square test between site and year since tooth loss.
Test applied: Chi-square test. N: Number of subjects. Statistically significant consider p<0.05

The parameters assessed included pair-wise mean differences in supraeruption between each group (1-5 years, 6-10 years, 11-15 years). There was a statistically significant difference in the mean supraeruption among groups with different periods of edentulism (p<0.001). However, there was no association between the site of supraeruption and the years since tooth loss (p<0.05).



[Table/Fig-13]: Mean values for supraeruption (in mm) with respect to years since tooth loss.

DISCUSSION

In the current study, photographs of the casts were captured and the extent of supraeruption was measured by generating a spline curve on a laptop using Adobe Photoshop software. According to the results, supraeruption increases in proportion to the number of years following tooth loss. The findings of the present study are consistent with those of Bhatt NN et al., where the total mean values of supraeruption ranged between 1.31 and 4.35 mm, with the highest percentages observed in the 21 to 60 months (1.9 to 5 years) of edentulism [6]. A similar study conducted by Al Moaleem MM et al., showed total mean values for supraeruption between 0.0 and 3.0 mm, with the highest percentages observed during 3 to 5 years of edentulism [5]. Craddock HL et al., mentioned that approximately 32% of teeth had supraeruption in excess of 2 mm and 6.7% had supraeruption in excess of 3 mm [1]. In the current study, however, 24.7% of teeth had supraeruption exceeding 2 mm and 9.87% exceeded 3 mm. Hakeem S et al., inferred that maxillary teeth were frequently unopposed, implying that missing teeth were common in the mandibular arch [7]. Lindskog-Stokland B et al., suggested that maxillary molars are more prone to overeruption due to the absence of occlusal resistance, contributing to the increased frequency of supraeruption in the upper arch [8]. Khan MS et al., conducted a study with findings consistent with the present research, observing a higher prevalence of supraerupted teeth in the maxillary arch, similar to the results of the current study [9]. Conversely, a study conducted by Al Moaleem MM et al., showed that supraeruption in mandibular teeth was more frequent than in the maxillary arch [5].

The stomatognathic system is generally considered to consist of three components: the teeth, the periodontal tissues and the articulatory system. The articulatory system is often the most overlooked part of the masticatory system [10]. Occlusion is not a permanent condition present since birth, but rather a dynamic system that develops through various phases of growth, development and maturation. It is characterised as adaptive rather than static throughout a patient's lifetime [11].

Occlusion encompasses the dynamic morphological and functional relationships among all components of the masticatory system, including the teeth and their supporting tissues, the temporomandibular joints, the neuromuscular system and the craniofacial skeleton. It is a critical aspect of dental health, influencing the efficiency of mastication, speech articulation and overall oral comfort. The loss of teeth causes altered proximal and occlusal contacts, leading to positional changes in adjacent teeth and the opposite arch, which can result in interferences and premature contacts during static or dynamic occlusion [2,12].

Supraeruption can disrupt occlusal harmony, affecting masticatory force and complicating subsequent restorative dentistry efforts [13]. As a result, mandibular movements may be impeded, leading to muscular incoordination and temporomandibular joint disorders. The harmony of occlusion can be disturbed by supraeruption, which is most commonly observed following the loss of posterior teeth, particularly the first permanent molar, followed by the second molar [14,15].

Addressing supraeruption requires a comprehensive approach that may involve orthodontic interventions, restorative procedures, or collaborative efforts among dental specialists [16]. Clinicians need a solid understanding of occlusal harmony concepts to identify and manage common issues related to occlusal disharmony. The challenge of the missing mandibular molar lies in the fact that, despite being the first permanent teeth to emerge in the oral cavity, they are often the first to be lost. If these crucial elements of occlusion are lost and neglected, they can disrupt the foundation of stomatognathic stability [17].

Supraeruption can be prevented by the light forces generated during chewing against an antagonist [18]. Re-establishing a functional posterior occlusion requires a comprehensive dental treatment plan when either a fixed or removable prosthesis is intended for the opposing edentulous arch [19].

The present study provides foundational information about supraeruption, though it is limited by a small sample size and the measurement of supraeruption made only in the occlusal direction. Movements such as tipping, drifting and rotation of supraerupted teeth and the opposing teeth were not investigated in the present study. Therefore, further research is necessary to examine the association between supraeruption and the duration of tooth loss, as well as site involvement.

Limitation(s)

The study was conducted at a specific institution, which may limit the generalisability of the findings to broader populations. It does not represent all ethnic groups or populations worldwide. Without longitudinal follow-up, changes in the progression of supraeruption cannot be dynamically assessed. Variables such as occlusal habits, periodontal status, systemic health, or the presence of removable prostheses were not controlled or adjusted for, which may have influenced the outcomes.

CONCLUSION(S)

The present study concluded that a statistically significant correlation was observed between supraeruption and the presence of missing opposing teeth. Supraeruption was found to be more prevalent in the maxillary arch than in the mandibular arch and a significant difference was noted between the mean extent of supraeruption and the duration of edentulism, suggesting that the length of time a tooth remains unopposed may influence the degree of vertical movement. The evidence discussed in this paper indicates that supraeruption is likely to occur in unopposed posterior teeth. All complications arising from non restored edentulous spaces affect the final prosthodontic treatment plan, whether for conventional fixed partial dentures or implant-supported crowns. In this context, it is essential for clinicians to address all complications arising from tooth loss initially. To draw more definitive conclusions, further studies involving larger sample sizes are necessary. Continued research and comprehensive investigations will help to overcome the limitations of the present study.

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