

## Prevalence and Associated Factors for Crossbite Malocclusion in South Indian Subjects - A Retrospective Study

Research Article

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### Abstract

Malocclusion is considered a major public health problem and crossbite is a major orthodontic discrepancy affecting many individuals throughout the world. This may affect the quality of life due to disturbances of oral health and dentofacial aesthetics. A retrospective study was conducted in a University Hospital from July 2019 till March 2020 to assess the prevalence and associated factor for crossbite malocclusion in the South Indian population. Sample sizes of 1017 patients were selected from the case records of patients who reported to the University Hospital for orthodontic treatment. The data variables such as sociodemographic data, presence of crossbite, site of crossbite and presence of class II malocclusion were tabulated and analyzed using SPSS Version 20. Descriptive statistics and Chi-Square tests were performed. A total of 60 records with crossbite were included. The overall prevalence of crossbite in class II malocclusion was 6%. Posterior crossbite was common in males (60%) and females (76%) compared to anterior crossbite. Meanwhile, posterior crossbite was common in class II division 1 (67%) and class II division 2 (60%) than anterior crossbite. However, There was no statistically significant association between gender and malocclusion with crossbite ( $p>0.05$ ). Thus, it can be concluded that the prevalence of crossbite in class II malocclusion was 6% and no significant difference was seen among gender and malocclusion with site of crossbite..

**Keywords:** Crossbite; Fixed Appliance; Malocclusion; Prevalence; Removable Appliance.

### Introduction

Crossbite can be defined as an abnormal relationship between one or more teeth in one arch to the opposing arch in the buccolingual or labiolingual direction [1]. It is a major orthodontic discrepancy affecting many individuals in various age ranges. However, crossbite usually develops during the growing phase of a child [2]. Interceptive orthodontic treatments are an early intervention to guide the eruption of teeth and correction of malocclusion and highly desirable [3]. Crossbite can be divided into anterior or posterior crossbite.

Anterior crossbite is defined by Salzman as the lingual placement of maxillary incisors in relation to the opposing mandibular teeth when both arches are in centric occlusion [4]. It can be further classified into dentoalveolar, skeletal and functional [5]. Single

tooth crossbite is usually seen in dentoalveolar anterior crossbite and skeletal crossbite usually seen due to retrognathic maxilla and prognathic mandible [6]. Functional crossbite is commonly seen in pseudo-class III malocclusion [6]. Clinically, anterior crossbite manifests with reverse overjet and premature tooth contact leading to the displacement of the mandible [7].

Posterior crossbite is defined by Foster as the occlusion of buccal cusps of the lower teeth outside the arch of the upper teeth [8]. It may be present as unilateral or bilateral crossbite involving single or multiple teeth in the functioning occlusal position [9]. The mechanism of posterior crossbite involves shifting of the mandible to one side where multiple and stable contacts occur, which results in tooth wear, abnormal growth and development of teeth and jaws [10]. Crossbite involving canines is considered as posterior crossbite [11].

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Several studies have reported the prevalence of crossbite. In a study done by Anistotoaei et al, the prevalence of posterior crossbite was 10.94% [12]. A study on the prevalence of crossbite in children with sucking habits reported that the tendency to develop posterior crossbite in the primary dentition is higher for pacifier suckers than for digit suckers [13]. Anterior and posterior crossbite in early mixed dentition is believed to be transferred from the primary to permanent dentition and can have long term effects on the growth and development of teeth and jaws [14]. Therefore, interceptive orthodontic treatment is advised to guide a normal occlusion. There are various challenges faced by the orthodontists such as dilacerated tooth, extrusion of fractured tooth, deep bite correction, bonding failure, obstructive sleep apnea, mini implant failures, maxillary hypoplasia in growing child and side effects of bisphosphonates on tooth movement [15-23].

However, to overcome the challenges, a proper diagnosis and treatment planning should be done. Besides that, the quantification of force delivered by orthodontic auxiliaries also plays an important role [24]. It is also important to understand the stressed produce along the surface of the implant to avoid mini implant failures [25, 26]. Previously our team has a rich experience in working on various research projects across multiple disciplines. [27-40]. Now the growing trend in this area motivated us to pursue this project.

Thus, the aim of the study was to assess the prevalence and associated factor for crossbite malocclusion in the South Indian population.

## Materials and Methods

A retrospective study was conducted involving patients visiting a dental hospital from July 2019 till March 2020. Ethical approval was granted by the Institutional Ethics Committee with the following ethical approval number SDC/SIHEC/2020/DIASDA-

TA/0619-0320.

Data was collected from the records of the patients who reported for orthodontic treatment in a University Hospital. Subjects with class II malocclusion and crossbite were included and subjects with temporomandibular joint disorder were excluded in the study. A total of 60 subjects with crossbite were selected in this study. To minimize bias, cross-verification was done using photographs and reviewed by the second reviewer.

Data variables including socio-demographic data such as age and gender, presence of crossbite, site of crossbite and presence of class II malocclusion were retrieved and recorded. Data were analyzed using Statistical Package for Social Science, SPSS Version 20 (IBM Corporation, New York, USA). A Chi-square test was done to establish the association between the categorical variables.

## Results & Discussion

The overall objective of this study was to evaluate the association of crossbite with class II malocclusion and its prevalence in the South Indian population. The study on prevalence helps the orthodontist to rule out early diagnosis and treatment plan for a better treatment outcome.

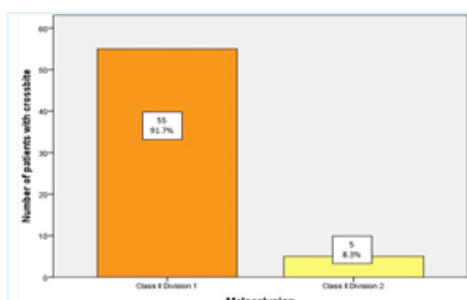
A total of 60 subjects were selected in the study out of which 58.3% were males and 41.7% were females as shown in Graph 1. The age range of the patients was 9-51 years with a mean age of 25 years. Crossbite was common in class II division 1 (91.7%) than class II division 2 (8.3%) as shown in Graph 2. Posterior crossbite (66.7%) was common followed by anterior crossbite (33.3%) as shown in Graph 3.

In the present study, the overall prevalence of crossbite in class II malocclusion was 6%. Anistoroaei et al reported that the prevalence of crossbite was 3.6%, in which the value was lesser than the present study [12]. Another study also reported that 2.7% of class

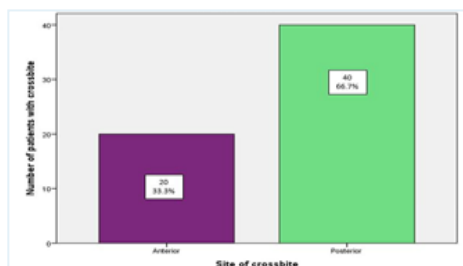
**Graph 1. Bar chart depicting the frequency distribution of crossbite based on gender. X-axis represents the gender and Y-axis represents the number of patients with crossbite. Blue denotes male patients and red denotes female patients. Crossbite was common in males (58.3%) than females (41.7%).**



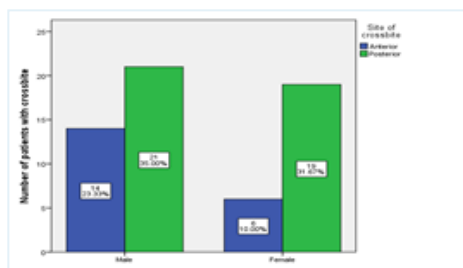
**Graph 2. Bar chart depicting the frequency distribution of crossbite based on the class II malocclusion. X-axis represents class II malocclusion and Y-axis represents the number of patients with crossbite. Orange denotes class II division 1 and yellow denotes class II division 2. Crossbite was common in class II division 1 (91.7%) than class II division 1 (8.3%).**



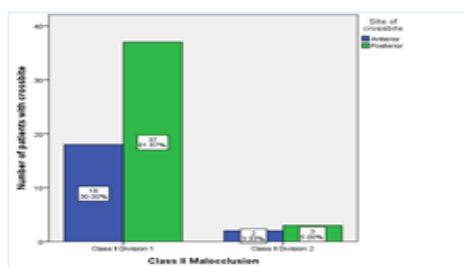
**Graph 3.** Bar chart depicting the frequency distribution of crossbite based on the sites of crossbite. X-axis represents sites of crossbite and Y-axis represents the number of patients with crossbite. Purple denotes anterior crossbite and green denotes posterior crossbite. Posterior crossbite (66.7%) was more common than anterior crossbite (33.3%).



**Graph 4.** The bar chart depicting the association of gender with the site of crossbites. X-axis represents gender and Y-axis represents the number of patients with crossbite. Blue denotes anterior crossbite and green denotes posterior crossbite. Chi-Square test was done and association was found to be not statistically significant. Pearson Chi-square value: 0.109a, df: 1, p-value: 0.741 (>0.05). In both male patients and female patients posterior crossbite was more common than anterior crossbite, and there was no significant association between gender and site of crossbite.



**Graph 5:** The bar chart depicting the association of class II malocclusion with the site of crossbite. X axis represents the class II malocclusion and Y axis represents the sites of crossbite. Blue denotes anterior crossbite and green denotes posterior crossbite. Chi-Square test was done and association was found to be not statistically significant. However, it is not statistically significant. Pearson Chi-square value: 1.680a, df: 1, p-value: 0.195 (>0.05). In both class II division 1 and class II division 2, posterior crossbite was more common than anterior crossbite and there was no significant association between class II malocclusion and site of crossbite.



II malocclusion had crossbite [13]. Sultana et al reported that the prevalence of crossbite in class II malocclusion was 18.4% which was higher compared to the present study [41]. Overall, we can observe that the prevalence of crossbite in class II malocclusion was lower compared to class I malocclusion in the previous studies [12, 41, 42].

Crossbite was more common in males (58.3%) than females (41.7%). Posterior crossbite was common in males (60%) and females (76%) compared to anterior crossbite as shown in Graph 4. However, there was no statistically significant association between gender and crossbite ( $p > 0.05$ ). Previous studies reported that crossbite in females was higher than males which were contrary to the present study [1, 12, 41, 43]. However, there was no statistically significant difference in the previous study which was similar to the present study [1, 12, 41, 43, 44]. In a study done by Woitchunas et al reported that males were predominant with crossbite which was similar to the present study [45]. According to the site of crossbite, a previous study reported that anterior crossbite was common in males with 35% and posterior crossbite was common in females with 47% which was contrary with the present study [41].

This present study also found that there was no statistically significant difference between class II malocclusion with crossbite ( $p > 0.05$ ). Posterior crossbite was common in class II division 1 (67%) and class II division 2 (60%) compared to anterior crossbite as shown in Graph 5. A previous study reported that there was a significant association between malocclusion with crossbite which was contrary to the present study [12]. However, it also reported that class II division 1 was more prevalent with crossbite with 3.1% compared to class II division 2 with 0.52% which is in line with the present study [12]. In a study done by Al-Dabagh in Yemen, there was no incidence of crossbite seen among class II malocclusion patients [(1)]. Moreover, this present study revealed that posterior crossbite (67%) was common compared to anterior crossbite (33%) which is similar to the previous study [46].

The study on the prevalence of crossbite provides information to the orthodontist regarding the importance of interceptive treatment to minimize the risk of crossbite as age increases. There are various treatment approaches depending on the diagnosis and prognosis of each case. Orthodontists use various analysis for diagnosis and treatment planning [35]. Sagittally linear cephalo-

metric dimensions can improve the efficiency diagnosis and treatment planning in class II and class III tendencies [47]. Meanwhile, gonial angle in cephalometric analysis can be used as an indicator in growth patterns [48]. The limitation of this study was a small sample size and observer bias. Further study can be done to associate crossbite with other etiological factors and evaluate various treatment approaches in managing crossbite cases. Our institution is passionate about high quality evidence based research and has excelled in various fields [49-59]. We hope this study adds to this rich legacy.

## Conclusion

Within the limitations of the study, it can be concluded that the overall prevalence of crossbite in class II malocclusion was 6%. Posterior crossbite was common in males and females and also in class II division 1 and class II division 2 malocclusion which was not significant.

## References

- Al-Dabagh DJ. The Prevalence of Crossbite of Young Adult Yemenis. *Journal of the College of Dentistry*. 2003;89.
- Alnfeiy M, Batt KH, Almontshary A, Bamakhrama M, Abbasi A. Prevalence of Cross-Bite among School Children in Riyadh City; An Epidemiological Study Conducted in the Schools of Riyadh.
- Kumar S, Roy AS, Chandna AK, Garg A, Chaudhary UK. Crossbite: An Orthodontic Exigency. *J Clin Diagn Res*. 2016 Sep;10(9):ZJ09-ZJ10. Pubmed PMID: 27790605.
- Salzmann JA. Handicapping malocclusion assessment to establish treatment priority. *Am J Orthod*. 1968 Oct;54(10):749-65. Pubmed PMID: 5245740.
- Phulari BS. *Orthodontics: Principles and Practice*, New Delhi: Jaypee Bros. 2011.
- Singh G. *Textbook of orthodontics*. Jaypee-Brother. 2004.
- Walther DP, Houston WJ. *Walther's Orthodontic Notes*. Butterworth-Heinemann; 1983
- Foster TD. *A Textbook of Orthodontics*. Blackwell Scientific Publications, Oxford.; 1975.
- Bishara SE, Saunders WB. *Textbook of orthodontics*. Saunders Book Company; 2001 Mar 21.
- Kennedy DB, Osepchook M. Unilateral posterior crossbite with mandibular shift: a review. *J Can Dent Assoc*. 2005 Sep;71(8):569-73. Pubmed PMID: 16202196.
- Ferro R, Besostri A, Olivieri A, Quinz V, Scibetta D. Prevalence of cross-bite in a sample of Italian preschoolers. *Eur J Paediatr Dent*. 2016 Dec;17(4):307-309. Pubmed PMID: 28045319.
- ANISTOROAEI D, SAVEANU IC, CERNEI ER, ZEGAN G. THE PREVALENCE OF POSTERIOR CROSSBITE IN A GROUP OF ROMANIAN PATIENTS. *International Journal of Medical Dentistry*. 2019 Apr 1;23(2).
- Modéer T, Odenrick L, Lindner A. Sucking habits and their relation to posterior cross-bite in 4-year-old children. *Scand J Dent Res*. 1982 Aug;90(4):323-8. Pubmed PMID: 6957971.
- McNamara JA Jr. Early intervention in the transverse dimension: is it worth the effort? *Am J Orthod Dentofacial Orthop*. 2002 Jun;121(6):572-4. Pubmed PMID: 12080303.
- Felicita AS. Orthodontic management of a dilacerated central incisor and partially impacted canine with unilateral extraction - A case report. *Saudi Dent J*. 2017 Oct;29(4):185-193. Pubmed PMID: 29033530.
- Felicita AS. Orthodontic extrusion of Ellis Class VIII fracture of maxillary lateral incisor - The sling shot method. *Saudi Dent J*. 2018 Jul;30(3):265-269. Pubmed PMID: 29942113.
- Kamisetty SK, Verma JK, Arun, Sundari S, Chandrasekhar S, Kumar A. SBS vs Inhouse Recycling Methods-An Invidio Evaluation. *J Clin Diagn Res*. 2015 Sep;9(9):ZC04-8. Pubmed PMID: 26501002.
- Jain RK, Kumar SP, Manjula WS. Comparison of intrusion effects on maxillary incisors among mini implant anchorage, j-hook headgear and utility arch. *J Clin Diagn Res*. 2014 Jul;8(7):ZC21-4. Pubmed PMID: 25177631.
- Viswanath A, Ramamurthy J, Dinesh SP, Srinivas A. Obstructive sleep apnea: awakening the hidden truth. *Niger J Clin Pract*. 2015 Jan-Feb;18(1):1-7. Pubmed PMID: 25511335.
- Samantha C, Sundari S, Chandrasekhar S, Sivamurthy G, Dinesh S. Comparative Evaluation of Two Bis-GMA Based Orthodontic Bonding Adhesives - A Randomized Clinical Trial. *J Clin Diagn Res*. 2017 Apr;11(4):ZC40-ZC44. Epub 2017 Apr 1. Pubmed PMID: 28571259.
- Ramesh Kumar KR, Shanta Sundari KK, Venkatesan A, Chandrasekar S. Depth of resin penetration into enamel with 3 types of enamel conditioning methods: a confocal microscopic study. *Am J Orthod Dentofacial Orthop*. 2011 Oct;140(4):479-85. Pubmed PMID: 21967934.
- Krishnan S, Pandian S, Kumar S A. Effect of bisphosphonates on orthodontic tooth movement-an update. *J Clin Diagn Res*. 2015 Apr;9(4):ZE01-5. Epub 2015 Apr 1. Pubmed PMID: 26023659.
- Vikram NR, Prabhakar R, Kumar SA, Karthikeyan MK, Saravanan R. Ball Headed Mini Implant. *J Clin Diagn Res*. 2017 Jan;11(1):ZL02-ZL03. Pubmed PMID: 28274084.
- Dinesh SP, Arun AV, Sundari KK, Samantha C, Ambika K. An indigenously designed apparatus for measuring orthodontic force. *J Clin Diagn Res*. 2013 Nov;7(11):2623-6. Pubmed PMID: 24392423.
- Sivamurthy G, Sundari S. Stress distribution patterns at mini-implant site during retraction and intrusion--a three-dimensional finite element study. *Prog Orthod*. 2016;17:4. Pubmed PMID: 26780464.
- Felicita AS. Quantification of intrusive/retraction force and moment generated during en-masse retraction of maxillary anterior teeth using mini-implants: A conceptual approach. *Dental Press J Orthod*. 2017 Sep-Oct;22(5):47-55. Pubmed PMID: 29160344.
- Jain AR. Prevalence of partial edentulousness and treatment needs in rural population of South India. *World Journal of Dentistry*. 2017 Jun;8(3):213-7.
- Varghese SS, Ramesh A, Veeraiyan DN. Blended Module-Based Teaching in Biostatistics and Research Methodology: A Retrospective Study with Post-graduate Dental Students. *J Dent Educ*. 2019 Apr;83(4):445-450. Pubmed PMID: 30745352.
- Ashok V, Ganapathy D. A geometrical method to classify face forms. *J Oral Biol Craniofac Res*. 2019 Jul-Sep;9(3):232-235. Pubmed PMID: 31198677.
- Padavala S, Sukumaran G. Molar incisor hypomineralization and its prevalence. *Contemporary clinical dentistry*. 2018 Sep;9(Suppl 2):S246.
- Ke Y, Al Aboody MS, Alturaiki W, Alsagaby SA, Alfaiz FA, Veeraraghavan VP, Mickymaray S. Photosynthesized gold nanoparticles from *Catharanthus roseus* induces caspase-mediated apoptosis in cervical cancer cells (HeLa). *Artif Cells Nanomed Biotechnol*. 2019 Dec;47(1):1938-1946. Pubmed PMID: 31099261.
- Ezhilarasan D. Oxidative stress is bane in chronic liver diseases: Clinical and experimental perspective. *Arab J Gastroenterol*. 2018 Jun;19(2):56-64. Pubmed PMID: 29853428.
- Krishnan RP, Ramani P, Sherlin HJ, Sukumaran G, Ramasubramanian A, Jayaraj G, Don KR, Santhanam A. Surgical Specimen Handover from Operation Theater to Laboratory: A Survey. *Ann Maxillofac Surg*. 2018 Jul-Dec;8(2):234-238. Pubmed: 30693238.
- Ezhilarasan D, Sokal E, Najimi M. Hepatic fibrosis: It is time to go with hepatic stellate cell-specific therapeutic targets. *Hepatobiliary Pancreat Dis Int*. 2018 Jun;17(3):192-197. Pubmed PMID: 29709350.
- Pandian KS, Krishnan S, Kumar SA. Angular photogrammetric analysis of the soft-tissue facial profile of Indian adults. *Indian J Dent Res*. 2018 Mar-Apr;29(2):137-143. Pubmed PMID: 29652003.
- Ramamurthy JA, Mg V. Comparison of effect of Hiora mouthwash versus Chlorhexidine mouthwash in gingivitis patients: A clinical trial. *Asian J Pharm Clin Res*. 2018 Jul 7;11(7):84-8.
- Gupta P, Ariga P, Deogade SC. Effect of Monopoly-coating Agent on the Surface Roughness of a Tissue Conditioner Subjected to Cleansing and Disinfection: A Contact Profilometric In vitro Study. *Contemp Clin Dent*. 2018 Jun;9(Suppl 1):S122-S126. Pubmed PMID: 29962776.
- Paramasivam A, Vijayashree Priyadharsini J, Raghunandhakumar S. N6-adenosine methylation (m6A): a promising new molecular target in hypertension and cardiovascular diseases. *Hypertens Res*. 2020 Feb;43(2):153-154. Pubmed PMID: 31578458.
- Palati S, Ramani P, Shrelin HJ, Sukumaran G, Ramasubramanian A, Don KR, Jayaraj G, Santhanam A. Knowledge, Attitude and practice survey on the perspective of oral lesions and dental health in geriatric patients residing in old age homes. *Indian J Dent Res*. 2020 Jan-Feb;31(1):22-25. Pubmed PMID: 32246676.
- Samuel SR, Acharya S, Rao JC. School Interventions-based Prevention of Early-Childhood Caries among 3-5-year-old children from very low socio-economic status: Two-year randomized trial. *J Public Health Dent*. 2020 Jan;80(1):51-60. Pubmed PMID: 31710096.
- Sultana N, Hassan GS, Jha D, Nashrin T, Nahar L, Naim MA. Prevalence of cross bite among the orthodontic patients in Bangabandhu Sheikh Mujib Medical University. *Bangladesh Journal of Medicine*. 2015 Nov 10;26(1):9-12.
- Bugaighis I, Karanth D. The prevalence of malocclusion in urban Libyan



- schoolchildren. *J Orthod Sci.* 2013 Jan;2(1):1-6. Pubmed PMID: 24987636.
- [43]. Naeem S, Asad S, Waheed--Ul Hamid M. Prevalence of cross bite in orthodontic patients. *Pakistan Oral & Dental Journal.* 2009;29:279-80.
- [44]. Asiry MA. Occlusal Status among 12-16 Year-Old School Children in Riyadh, Saudi Arabia. *J Int Oral Health.* 2015 May;7(5):20-3. Pubmed PMID: 26028897.
- [45]. Woitchunas DR, Busato C, Tochetto LR, Brockstedt RH. Anterior cross-bite: diagnosis and treatment of pseudoclass III-clinical case report. *Rev Fac Odontol UPE.* 2001;6(2):23-8.
- [46]. Chowdhury MS, Sultana N, Naim MA, Nashrin T, Nahar L. Prevalence of Cross Bite among the Orthodontic Patients at a Dental Unit of Bangladesh. *Journal of National Institute of Neurosciences Bangladesh.* 2019 Sep 7;5(2):167-71.
- [47]. Felicita AS, Chandrasekar S, Shanthasundari KK. Determination of cranio-facial relation among the subethnic Indian population: a modified approach - (Sagittal relation). *Indian J Dent Res.* 2012 May-Jun;23(3):305-12. doi: 10.4103/0970-9290.102210. PMID: 23059564.
- [48]. Rubika J, Felicita AS, Sivambiga V. Gonial angle as an indicator for the prediction of growth pattern. *World J Dent.* 2015;6(3):161-3.
- [49]. Vijayashree Priyadharsini J. In silico validation of the non-antibiotic drugs acetaminophen and ibuprofen as antibacterial agents against red complex pathogens. *J Periodontol.* 2019 Dec;90(12):1441-1448. Pubmed PMID: 31257588.
- [50]. J PC, Marimuthu T, C K, Devadoss P, Kumar SM. Prevalence and measurement of anterior loop of the mandibular canal using CBCT: A cross sectional study. *Clin Implant Dent Relat Res.* 2018 Aug;20(4):531-534. Pubmed PMID: 29624863.
- [51]. Ramesh A, Varghese S, Jayakumar ND, Malaiappan S. Comparative estimation of sulfiredoxin levels between chronic periodontitis and healthy patients - A case-control study. *J Periodontol.* 2018 Oct;89(10):1241-1248. Pubmed PMID: 30044495.
- [52]. Ramadurai N, Gurunathan D, Samuel AV, Subramanian E, Rodrigues SJL. Effectiveness of 2% Articaine as an anesthetic agent in children: randomized controlled trial. *Clin Oral Investig.* 2019 Sep;23(9):3543-3550. Pubmed PMID: 30552590.
- [53]. Sridharan G, Ramani P, Patankar S, Vijayaraghavan R. Evaluation of salivary metabolomics in oral leukoplakia and oral squamous cell carcinoma. *J Oral Pathol Med.* 2019 Apr;48(4):299-306. Pubmed PMID: 30714209.
- [54]. Ezhilarasan D, Apoorva VS, Ashok Vardhan N. Syzygium cumini extract induced reactive oxygen species-mediated apoptosis in human oral squamous carcinoma cells. *J Oral Pathol Med.* 2019 Feb;48(2):115-121. Pubmed PMID: 30451321.
- [55]. Mathew MG, Samuel SR, Soni AJ, Roopa KB. Evaluation of adhesion of Streptococcus mutans, plaque accumulation on zirconia and stainless steel crowns, and surrounding gingival inflammation in primary molars: randomized controlled trial. *Clin Oral Investig.* 2020 Sep;24(9):3275-3280. Pubmed PMID: 31955271.
- [56]. Samuel SR. Can 5-year-olds sensibly self-report the impact of developmental enamel defects on their quality of life? *Int J Paediatr Dent.* 2021 Mar;31(2):285-286. Epub 2020 May 29. Pubmed PMID: 32416620.
- [57]. Hannah R, Ramani P, Ramanathan A, Gheena S, Ramasubramanian A, Monika K. CYP2 C9 polymorphism among patients with oral squamous cell carcinoma and its role in altering the metabolism of benzo [a] pyrene. *Oral Surgery, Oral Medicine, Oral Pathology and Oral Radiology.* 2020 Sep 1;130(3):306-12.
- [58]. Chandrasekar R, Chandrasekhar S, Sundari KKS, Ravi P. Development and validation of a formula for objective assessment of cervical vertebral bone age. *Prog Orthod.* 2020 Oct 12;21(1):38. Pubmed PMID: 33043408.
- [59]. Vijayashree Priyadharsini J, Smiline Girija AS, Paramasivam A. In silico analysis of virulence genes in an emerging dental pathogen *A. baumannii* and related species. *Arch Oral Biol.* 2018 Oct;94:93-98. Epub 2018 Jul 7. Pubmed PMID: 30015217.