International Journal of Dentistry and Oral Science (IJDOS)
ISSN: 2377-8075

Association Of Mandibular Arch Crowding And Vertical Growth Pattern - A Retrospective Study

Research Article

Nor Syakirah binti Shahroom[1], Ravindra Kumar Jain[2*], Iffat Nasim[3]

[1] Saveetha Dental College and Hospitals, Saveetha Institute of Medical and Technical Sciences, Saveetha University, Chennai 600077, Tamil Nadu, India.
[2] Associate Professor, Department of Orthodontics, Saveetha Dental College and Hospital, Saveetha Institute of Medical and Technical Sciences, Saveetha University, Chennai 600077, Tamil Nadu, India.
[3] Professor, Department of Conservative Dentistry and Endodontics, Saveetha Dental College and Hospital, Saveetha Institute of Medical and Technical Sciences, Saveetha University, Chennai 600077, Tamil Nadu, India.

Abstract

Dental arch crowding is one of the most common malocclusions encountered in daily practice by an orthodontist. The most common reason that motivates patients to seek orthodontic treatment is anterior crowding as it has a significant aesthetic problem. A retrospective study was conducted in a dental hospital from July 2019 till March 2020 to evaluate the prevalence of dental arch crowding in subjects with vertical growth patterns in the Chennai population. A sample of 127 subjects with vertical growth patterns were selected from the case records of patients who reported to the University Hospital for orthodontic treatment. Mandibular arch crowding was classified into mild, moderate and severe crowding and cross verified with photographs. All the data was tabulated and analyzed using SPSS Version 20. Descriptive statistics and Chi-Square tests were performed. The overall prevalence of mandibular arch crowding in subjects with vertical growth patterns was 72%. Crowding was common in males (54.3%) than females (45.7%). Mild crowding (48%) was more prevalent followed by moderate crowding (27.6%) and severe crowding (24.4%). Mandibular arch crowding was more common in adults (44.9%) followed by adolescents (31.5%) and children (23.6%). No statistically significant association between age, gender and type of malocclusion of subjects with severity of crowding was noted ($p>0.05$). It can be concluded that the prevalence of crowding in subjects with vertical growth patterns was 72% and no differences among age, gender and type of malocclusion with crowding was noted.

Keywords: Crowding; Lateral Cephalograms; Malocclusion; Orthodontic; Vertical Growth Pattern.

Introduction

An individual who faces a problem with socialization due to aesthetic reasons might visit a dental clinic to consult for aesthetic enhancement. Most of the patients feel that crowding is non-aesthetic and that motivates them to seek treatment. Crowding can be defined as the presence of a discrepancy between teeth size and the available space for their correct functional and aesthetic position, which may affect oral health by increasing susceptibility to dental caries and periodontal disease and further will influence the dental and facial aesthetics of the patients [1].

There are various etiologic factors for crowding including evolution, genetics, environment, tooth size, tooth shape, arch length, intercanine width, intermolar width, and arch dimension [19, 30, 47]. Based on the definition above, crowding occurs not merely because of tooth-arch discrepancy but discrepancy among many variables [50]. Several factors can be assumed to affect the development and severity of crowding such as the direction of mandibular growth, the early loss of deciduous molars, mesiodistal tooth and arch dimensions, oral and perioral musculature and incisor and molar inclination [3, 19, 43].

Relevant to mandibular growth a pattern, the more vertical growth is, the greater the eruption of incisors to compensate for the vertical space created. This eruption decreases the likelihood to maintain contacts between the teeth and increase the risk of crowding [5]. There was a study which proved that there was a correlation between skeletal growth pattern with lower incisor crowding [27].

The most significant diagnostic advancements in orthodontics is

***Corresponding Author**:
Ravindra Kumar Jain,
Associate Professor, Department of Orthodontics, Saveetha Dental College and Hospital, Saveetha Institute of Medical and Technical Sciences, Saveetha University, Chennai 600077, Tamil Nadu, India.
Tel: +919884729660
E-mail: ravindrakumar@saveetha.com

Received: July 30, 2021
Accepted: August 11, 2021
Published: August 18, 2021

Citation: Nor Syakirah binti Shahroom, Ravindra Kumar Jain, Iffat Nasim. Association Of Mandibular Arch Crowding And Vertical Growth Pattern - A Retrospective Study. *Int J Dentistry Oral Sci.* 2021;8(8):4096-4100. doi: http://dx.doi.org/10.19070/2377-8075-21000836

radiographic cephalometry [18, 33] . In cephalogram analysis, the gonial angle is used to determine the growth pattern and rotation of the mandible in a patient [44]. The drawbacks of the cephalometric analyses are due to anatomical variation and growth changes occurring in different anatomical landmarks [14]. Another imaging modality in orthodontics is cone-beam computed tomography (CBCT) technology which offers an undistorted view of the dentition and three dimensional (3D) spatial orientation of the teeth and roots [18]. Besides that, it can also reveal the dimensions of alveolar bone and space limitations for intrusion and expansion [18]. Thus, advance diagnosis is required to ensure that the treatment planning and outcome are favorable depending on the various dental or skeletal malocclusions. Moreover, to predict the outcome of the treatment, it is important to have knowledge regarding the forces exerted on the orthodontic auxiliaries in which indigenous apparatus is found to be efficient [7, 13, 40]. Previously our team has a rich experience in working on various research projects across multiple disciplines [2, 8, 10, 16, 20-25, 31-34, 38, 49, 55, 58]. Now the growing trend in this area motivated us to pursue this project.

Therefore, the aim of this study was to evaluate the association of mandibular arch crowding with vertical growth patterns.

Materials and Methods

A retrospective study was conducted involving patients visiting dental hospitals from July 2019 till March 2020. Ethical approval was granted by the Institutional Ethics Committee with the following ethical approval number SDC/SIHEC/2020/DIASDATA/0619-0320.

Data was collected from the records of the patients who reported for orthodontic treatment in a University Hospital. Non orthodontically treated subjects with vertical growth patterns were selected in the study. Exclusion criteria were subjects with other growth patterns and undergoing orthodontic treatment. A total of 127 subjects with vertical growth patterns were selected in this study. To minimize bias, all data were included and no sorting process was done. Cross verification was done using photographs.

Sociodemographic data including age and gender, the severity of crowding, and the type of malocclusion were recorded. The severity of crowding was classified into mild, moderate and severe crowding.

Data was 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

In this present study, the prevalence of mandibular arch crowding in subjects with vertical growth patterns was 72%. In the study done by Ghulam Rasul et al, 92.6% of patients with hyper divergent facial growth had lower anterior crowding in which the value was higher than the present study and there was a significant difference between growth pattern and anterior crowding [41]. Few studies also reported a positive relationship between crowding with high mandibular plane angles and facial heights [27, 45].

Meanwhile, another study reported that the prevalence of crowding was 10% in vertical growth pattern patients and there was no statistically significant difference, which indicates that there was no relationship between growth pattern and mandibular crowding [29]. Miethke et al also concluded that there was no correlation between primary mandibular anterior crowding with vertical craniofacial configuration [29]. However, with regard to the mandibular growth a pattern, the more vertical growth is, the greater the eruption of incisors to compensate for the vertical space created. This eruption decreases the likelihood to maintain contacts between the teeth and increase the risk of crowding [5].

Crowding was more common in males (54.3%) than females (45.7%). Based on Figure 3, moderate (54.3%) and severe crowd-

Figure 1. Bar chart showing the frequency distribution of gender. X-axis represents gender and Y-axis represents the number of patients with crowding. Blue color denotes male Patients and purple color denotes female patients. Mandibular arch crowding was common in male patients (54.3%) than female patients (45.7%).

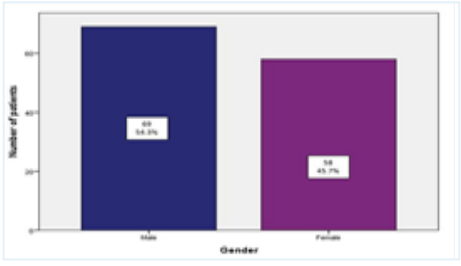


Figure 2. Bar chart showing the frequency distribution age group. X-axis represents the age and Y-axis represents the number of patients with crowding. Purple denotes child, blue denotes adolescent and red denotes adult. Mandibular arch crowding was common in adults (44.9%), followed by adolescent (31.5%) and child (23.6%).

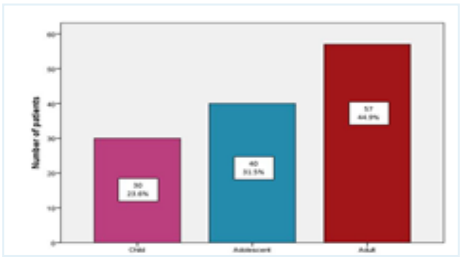


Figure 3. Bar chart depicting the association of gender with the severity of crowding. X-axis represents the gender and Y axis represents the number of patients with crowding. Blue color denotes mild, green color denotes moderate and brown color denotes severe. Chi-Square test was done and association was found to be not statistically significant. Pearson Chi-square value: 1.948a, df: 2, p-value: 0.378 (>0.05). Mild crowding was common in females and moderate and severe crowding were common in males but no significant difference was present.

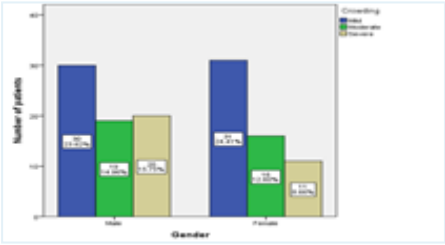


Figure 4. Bar chart depicting the association of age with the severity of crowding. X-axis represents the age and Y-axis represents the number of patients with crowding. Blue color denotes mild, green color denotes moderate and brown color denotes severe. Chi-Square test was done and association was found to be not statistically significant. Pearson Chi-square value: 7.202a, df: 4, p-value: 0.127 (>0.05). Mild and severe crowding were common in adults and moderate crowding was common in children but no significant difference was present.

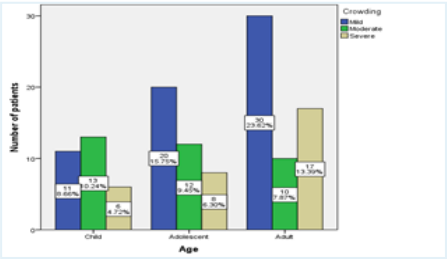


Figure 5. Bar chart showing the frequency distribution of types of malocclusion. X-axis represents the type of malocclusion and Y-axis represents the number of patients with crowding. Green color denotes class I, red color denotes class II and pink color denotes class III. Mandibular arch crowding was common in class I (56.7%) followed by class II (39.4%) and class III (3.9%) malocclusion.

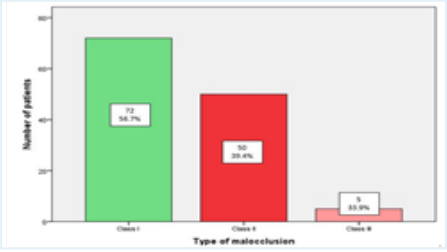
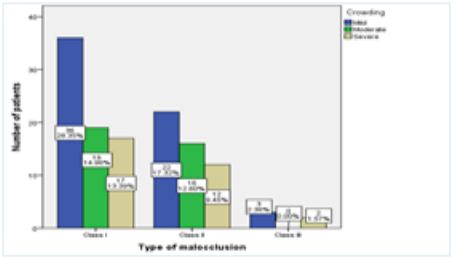


Figure 6. Bar chart depicting the association between type of malocclusion and severity of crowding. X-axis represents the type of malocclusion and Y-axis represents the number of patients with crowding. Chi-Square test was done and association was found to be not statistically significant. Pearson Chi-square value: 2.668a, df: 4, p-value: 0.651 (>0.05). Mild (59%), moderate (54.3%) and severe (54.8%) crowding were common in class I malocclusion but no significant difference was present.



ing (64.5%) were more common in males than females. Meanwhile, mild crowding was more common in females (50.8%) than males (49.2%). However, the present study revealed that there was no statistically significant association between gender and severity of crowding, p>0.05. With regard to the severity of crowding, a previous study reported that severe crowding was common in males with 26% which was similar to the present study where 64.5% of males had severe crowding [41]. This study also revealed that there was no statistically significant difference between gender and crowding which was in line with the present study. However, in a study done by Hamasha et al, there was a statistically significant difference between gender and crowding in which the females were common with 45.5% than males with 32.4% [17].

The present study also found that there was no statistically significant association between age and severity of crowding, p>0.05. Mandibular arch crowding was common in adults (44.9%) followed by adolescents (31.5%) and children (23.6%). Based on Figure 4, mild crowding (49.2%) and severe crowding (54.8%) were more common in adults and moderate crowding (37.1%) was more common in children. A previous study reported that the prevalence of severe crowding in adolescents and adults in the Netherlands was 15% [4]. Another study reported that 14.3% of adolescents had crowding [15]. The incidence as well as the severity of the crowding increased during adolescence and adulthood in both normal untreated individuals and orthodontically treated patients [52]. There was no study reported an association between the severity of crowding with different age groups.

Based on the type of malocclusion, mandibular arch crowding

was common in class I (56.7%) followed by class II (39.4%) and Class III (3.9%) malocclusion as shown in Figure 5. Based on Figure 6, mild crowding was common in class I (59%), class II (54.3%) and class III (54.8%) malocclusion. However, there was no statistically significant association between types of malocclusion with the severity of crowding, p>0.05.A previous study reported the severity of crowding in maxillary and mandibular arch based on types of malocclusion in which moderate maxillary crowding and mild mandibular crowding was common in all malocclusion groups [51]. In contrast to the study done by Shakeel Qutub et al, the study reported that there was a statistically significant difference between types of malocclusion and crowding in which maxillary crowding and mild mandibular crowding were more common in all malocclusion groups [24].

Numerous treatment protocols have been advocated for the management of malocclusion. It is important to carefully diagnose all cases to ensure a good treatment plan and outcomes. For example, in deep bite cases with vertical growth patterns, mini implants provide better outcomes in opening the bite [21, 59]. Nowadays, mini implant is considered an essential component in orthodontic treatment in resistance to unwanted tooth movement [11, 53]. Meanwhile, a new innovation on mini implants such as a ball headed mini-implant was created to achieve a proper skeletal change instead of dental change [22, 58]. However, in skeletal deep bite cases with a horizontal growth pattern and anterior crowding, extraction of premolars are not necessarily required and extraction of lower anterior teeth may provide a favorable prognosis [11, 26, 46].

The limitations of this study were the small sample size and the possibility of observer bias. Further study can be done to evaluate the various treatment approaches in managing cases with different severity of crowding and vertical growth pattern.

Our institution is passionate about high quality evidence based research and has excelled in various fields [2, 8, 10, 16, 20-25, 31-34, 38, 49, 55, 58]. We hope this study adds to this rich legacy.

Conclusion

Within the limitations of the study, it can be concluded that the prevalence of crowding in subjects with vertical growth patterns was 72% and no differences among age, gender and type of malocclusion with severity of crowding was noted.

References

[1]. Amaral MG, López LV. Prevalence, types and etiologic factors of mandibular crowding in orthodontic patients in Tabasco, Mexico, 2015-2016. Revista Mexicana de Ortodoncia. 2018 Apr 6;6(1):22-7.

[2]. 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.

[3]. BJORK A. Variations in the growth pattern of the human mandible: longitudinal radiographic study by the implant method. J Dent Res. 1963 Jan-Feb;42(1)Pt 2:400-11. Pubmed PMID: 13971295.

[4]. Burgersdijk R, Truin GJ, Frankenmolen F, Kalsbeek H, van't Hof M, Mulder J. Malocclusion and orthodontic treatment need of 15-74-year-old Dutch adults. Community Dent Oral Epidemiol. 1991 Apr;19(2):64-7. Pubmed PMID: 2049924.

[5]. Buschang PH. Class I malocclusions—The development and etiology of mandibular malalignments. InSeminars in Orthodontics 2014 Mar 1 (Vol. 20, No. 1, pp. 3-15). WB Saunders.

[6]. 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.

[7]. 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. doi: 10.7860/JCDR/2013/7143.3631. Epub 2013 Oct 24. Pubmed PMID: 24392423

[8]. Ezhilarasan D. Oxidative stress is bane in chronic liver diseases: Clinical and experimental perspective. Arab J Gastroenterol. 2018 Jun;19(2):56-64. doi: 10.1016/j.ajg.2018.03.002. Epub 2018 May 28. PMID: 29853428.

[9]. 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.

[10]. 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. doi: 10.1016/j.hbpd.2018.04.003. Epub 2018 Apr 21. Pubmed PMID: 29709350.

[11]. 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. doi: 10.1016/j.sdentj.2017.04.001. Pubmed PMID: 29033530.

[12]. 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.

[13]. 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.

[14]. Felicita AS, Chandrasekar S, Shanthasundari KK. Determination of craniofacial relation among the subethnic Indian population: a modified approach - (Sagittal relation). Indian J Dent Res. 2012 May-Jun;23(3):305-12. Pubmed PMID: 23059564.

[15]. Gábris K, Márton S, Madléna M. Prevalence of malocclusions in Hungarian adolescents. Eur J Orthod. 2006 Oct;28(5):467-70. Pubmed PMID: 16923783.

[16]. 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.

[17]. Abed AH, Alfehaid HA, Alqahtani NA, Alhusseini SA, Alomar RK, Almayouf NA, Aljuhaimi NF, Almasoud AA. Prevalence and factors associated with dentofacial characteristics of malocclusion among Saudi adults: A cross-sectional study. International Journal of Medical Research & Health Sciences. 2019;8(11):23-31.

[18]. Han M, Wang RY, Liu H, Zhu XJ, Wei FL, Lv T, Wang NN, Hu LH, Li GJ, Liu DX, Wang CL. Association between mandibular posterior alveolar morphology and growth pattern in a Chinese population with normal occlusion. J Zhejiang Univ Sci B. 2013 Jan;14(1):25-32. Pubmed PMID: 23303628.

[19]. Howe RP, McNamara JA Jr, O'Connor KA. An examination of dental crowding and its relationship to tooth size and arch dimension. Am J Orthod. 1983 May;83(5):363-73. Pubmed PMID: 6573844.

[20]. 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.

[21]. 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.

[22]. Kamisetty SK, Verma JK, Arun, Sundari S, Chandrasekhar S, Kumar A. SBS vs Inhouse Recycling Methods-An Invitro Evaluation. J Clin Diagn Res. 2015 Sep;9(9):ZC04-8. Pubmed PMID: 26501002.

[23]. 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.

[24]. Khan SQ, Ashraf B, Khan AQ, Mehdi H. PREVALENCE OF MALOCCLUSION AND ITS RELATION WITH CROWDING AND SPACING. Pakistan Oral & Dental Journal. 2014 Sep 30;34(3).

[25]. 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 PMID: 30693238.

[26]. 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. Pubmed PMID: 26023659.

[27]. Leighton BC, Hunter WS. Relationship between lower arch spacing/crowding and facial height and depth. Am J Orthod. 1982 Nov;82(5):418-25. Pubmed PMID: 6961812.

[28]. 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.

[29]. Miethke RR, Behm-Menthel A. Correlations between lower incisor crowding and lower incisor position and lateral craniofacial morphology. Am J Orthod Dentofacial Orthop. 1988 Sep;94(3):231-9. Pubmed PMID: 3046330.

[30]. Norderval K, Wisth PJ, Böe OE. Mandibular anterior crowding in relation to tooth size and craniofacial morphology. Scand J Dent Res. 1975 Sep;83(5):267-73. Pubmed PMID: 1058520.

[31]. Padavala S, Sukumaran G. Molar Incisor Hypomineralization and Its Prevalence. Contemp Clin Dent. 2018 Sep;9(Suppl 2):S246-S250. Pubmed PMID: 30294152.

[32]. 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.

[33]. 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.

[34]. 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.

[35]. 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.

[36]. Perera PS. Rotational growth and incisor compensation. Angle Orthod. 1987 Jan;57(1):39-49. Pubmed PMID: 3469927.

[37]. 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.

[38]. 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.

[39]. 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.

[40]. 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.

[41]. Rasul G, Khan AA, QIAM F. The role of vertical parameters in the development of lower incisor crowding amongst patients. Pakistan Oral & Dental Journal. 2012 Aug 1;32(2).

[42]. 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.

[43]. Rönnerman A, Thilander B. Facial and dental arch morphology in children with and without early loss of deciduous molars. Am J Orthod. 1978 Jan;73(1):47-58. Pubmed PMID: 271472.

[44]. 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.

[45]. SAKUDA M. Changes in crowding of teeth during adolescence and their relation to the growth of the facial skeleton. Trans Eur Orthod Soc. 1976;1976:93-104.

[46]. Samantha C, Sundari S, Chandrasekhar S, Sivamurty 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. Pubmed PMID: 28571259.

[47]. Sampson WJ, Richards LC. Prediction of mandibular incisor and canine crowding changes in the mixed dentition. Am J Orthod. 1985 Jul;88(1):47-63. Pubmed PMID: 3860012.

[48]. 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. Pubmed PMID: 32416620.

[49]. Samuel SR, Acharya S, Rao JC. School Interventions-based Prevention of Early-Childhood Caries among 3-5-year-old children from very low socioeconomic status: Two-year randomized trial. J Public Health Dent. 2020 Jan;80(1):51-60. Pubmed PMID: 31710096.

[50]. Sanin C, Savara BS. Factors that affect the alignment of the mandibular incisors: a longitudinal study. Am J Orthod. 1973 Sep;64(3):248-57. Pubmed PMID: 4516457.

[51]. Sayin MO, Türkkahraman H. Malocclusion and crowding in an orthodontically referred Turkish population. Angle Orthod. 2004 Oct;74(5):635-9. Pubmed PMID: 15529498.

[52]. Sidlauskas A, Trakiniene G. Effect of the lower third molars on the lower dental arch crowding. Stomatologija. 2006;8(3):80-4. PMID: 17191063.

[53]. 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.

[54]. 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.

[55]. Varghese SS, Ramesh A, Veeraiyan DN. Blended Module-Based Teaching in Biostatistics and Research Methodology: A Retrospective Study with Postgraduate Dental Students. J Dent Educ. 2019 Apr;83(4):445-450. Pubmed PMID: 30745352.

[56]. 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.

[57]. 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. Pubmed PMID: 30015217.

[58]. 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.

[59]. 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.