

Evaluation Of Palatal Rugae Patterns And Gender Determination With Malocclusion In Indian Population

Running Title: Rugoscopy And Gender Determination In Malocclusion Individuals

Type Of Study: Original Study

Authors:

Tahoor Taskeen L¹, Lavanya Prathap^{2,*}

1. Tahoor Taskeen .L

Saveetha Dental College And Hospitals
Saveetha Institute Of Medical And Technical Sciences (Simats)
Saveetha University, Chennai- 77
Email Id: 151901044.Sdc@Saveetha.Com

2. Lavanya Prathap,

Associate Professor
Department Of Anatomy
Saveetha Dental College And Hospitals
Saveetha Institute Of Medical And Technical Sciences (Simats)
Saveetha University, Chennai - 77
Email Id: Lavanyap.Sdc@Saveetha.Com
<https://Orcid.Org/0000-0002-9334-400x>

***Corresponding Author**

Dr. Lavanya Prathap

Associate Professor
Department Of Anatomy
Saveetha Dental College And Hospitals
Saveetha Institute Of Medical And Technical Sciences (Simats)
Saveetha University, Chennai - 77
Email Id: Lavanyap.Sdc@Saveetha.Com
<https://Orcid.Org/0000-0002-9334-400x>

Abstract:

Introduction: Palatal Rugae Is The Array Of Transverse Ridges Which Is Present On Anterior Region Of Hard Palate, Either Side Of Median Palatal Raphe. Rugoscopy Which Promotes Sex Determination And Identification Of Individual Due To Its Perenity And Stability As It Is Not Altered During Growth. Thus, The Study Aimed To Analyze The Association Of Rugoscopy And Dental Malocclusion Along With Gender Determination. **Materials And Methods:** The Study Setting Was Organized In A Dental College, 17 Dental Casts Were Collected And Segregated As Malocclusion And Normal Occlusion And The Rugae Patterns Were Determined Based On Classification Of Kapali And Thomas And Kotze And The Collected Data Was Calculated In Spss Version 23.0. **Results:** The Results Suggest That In Individuals The Maximum Number Of Rugae Were Seen Among Men With Mean Value 70. Based On The Occlusion, The Dominating Pattern Was Fragmented Rugae (20%) And Curve(25%) Whereas In Malocclusion The More Predominant Pattern Was Primary And Wavy. Based On Gender Wavy (Mean-27) And Secondary Rugae (Mean- 32) Was Predominantly Found For Females Whereas In Males Primary Rugae (Mean-28) And Wavy (Mean- 31) Was Found Predominant. Accordingly The Most Predominant Pattern Observed Among The Individuals Was Secondary Rugae (Mean- 55) And Wavy (Mean- 58). **Conclusion:** Thus The Predominant Pattern Among Individuals Was Secondary Rugae And Wavy And Based On Gender Females Had Predominant Secondary Rugae And Males Had Primary Rugae And Wavy Pattern.

Keywords: Palatal Rugae Pattern, Rugoscopy, Gender Determination, Malocclusion, Dental Casts, Innovative Technique, Eco- Friendly.

Introduction:

Forensic Science Involves The Identification Of The Cause For The Tragedies With The Individual Affected Or Involved In The Violence (1). This Science Of Identification Involves Many Reliable Primary Means Such As Fingerprint Determination, And Dna Evaluation Among Which Palatal Rugae Is Seen To Be A Potent Ideal Parameter Of Forensic. Palatal Rugae Is The Array Of Transverse Ridges Which Is Present On Anterior Region Of Hard Palate (2) (3). It Is Otherwise Called Plicae Palatinae Transversae. Palatoscopy Or Rugoscopy Is The Study Of Palatal Rugae Patterns Which Promotes Sex Determination And Identification Of Individual Due To Its Perenity And Stability As It Is Not Altered During Growth. Rugae Patterns Are Developed At The Third Month Of Intrauterine Which Initially Occupies More Length Of Palatal Shelves At The Course Of Its Elevation (4) (5). Malocclusion Refers To The Irregular Location Of The Teeth. Because Tooth Development Begins In The Womb, It Is Thought To Be Linked To Hereditary Factors (6). Because Both The Palatal Rugae And Tooth Formation Occur In The Foetus, They Are Thought To Be Linked. It's Now Been Discovered That It Can Function As A Precursor Messenger For A Variety Of Congenital Disorders And Malocclusions (7).

Thomas And Kotze Proposed The Classification Of Palatal Rugae Based On Rugae Measurement: Primary Ruga (Less Than 5 Mm), Secondary Ruga (3–5 Mm), And Fragmented Ruga. (2–3 Mm)(8). In Other Classification Of Palatal Rugae Based On Its Shape And Direction It Has Been Classified As Curve, Wavy, Circular, Straight, Diverging (Away From The Median Raphe) And Converging (Towards The Median Raphe)(9). Similarly, Malocclusion Is Divided Into Three Types Based On The Angle: Class I, Class Ii, And Class Iii (10). Malformations Such As Deep Bite, Proclination, Cross Bite, Scissor Bite, Crowding, And Spacing Are Also Present..

A Recent Study Done By Shetty D Et Al In 2013 Had Reported That Though The Bony Structures Changes After Orthodontic Treatment The Rugae Is Secured Without Changes Which Makes It Unique For Every Individual And Acts As An Indicator In Forensic Odontology (11). Similarly, Rajan Vp Et Al In 2013 The Palatal Rugae Patterns Were Discovered In Youngsters Aged 5 To 15 Years Old, And Their Uniqueness Was Documented. (12) Whereas Another Recent Study Done By Chong Ja Et Al In 2020 Declared That Though Rugae Pattern Shows Individual Characteristics It Has Similarity Among Siblings (Hereditary Factor) Which Is Influenced By Environmental And Genetical (12).

The Current Study Exclusively Detects The Association Between Palatal Rugae And Malocclusion Along With Sex Determination, As Pervious Researches Are Based Either Only On Association Of Paltal Rugae And Malocclusion Or Palatal Rugae Over Sex Determination. According To The Palatal Rugae Study, There Are Less Studies In The Research Field, Thus This Is A Unique Contribution To The Field. We Can't Generalise The Results Because Our Sample Size Is So Small. As A Result, We're Striving To Make A Contribution To The Field Of Research. Comprehensive Knowledge And Research Experience Is Present In Our Team Which Has Translated Into High Quality Publications (13–20),(21),(22),(23),(24,25),(26),(27),(28–32) The Current Study Attempted To Investigate The Relationship Between Rugoscopy And Malocclusion, As Well As Gender Determination.

Materials And Methods:

With A Sample Size Of 17 Dental Casts, The Current Investigation Was Conducted In A Private Dental College And Hospital. Malocclusion And Class I Normal Occlusion Were Separated. The Institutional Review Board Gave Their Approval To The Project. The Dental Casts Were Gathered And Segregated According To The Certified Dentist's Diagnosis, And Their Rugae Patterns Were Photographed With A Digital Camera. The Rugae Patterns Such As Curve, Wavy, Circular, Straight, Diverging , Converging And Depending On Size Primary, Secondary, Fragmented Of Right And Left Rugae Patterns To Median Raphe Were Taken For Outcome Measure And Observed The Rugae Pattern And Counted And Measured With A Measuring Scale To Differentiate Primary, Secondary And Fragmented Rugae Patterns. The Total Rugae Count And Mean Rugae Count Were Calculated Using A Computer In Microsoft Excel, And The Significance Of The Differences Between The Groups Was Determined Using The Chi

Square And T Test In Spss Version 23.0. From One End To The Median Raphe, The Rugae Patterns Are Tallied. The Mean Palatal Rugae Count Of Each Sample Was Computed After The Digital Rugae Counts Were Evaluated..

Result:

In The Current Study Based On The Obtained Results The Frequency Distribution Of Primary Rugae Pattern Greater Than 3mm Was 15% For 5mm Among The Individuals, Whereas The Frequency Distribution Of Primary Rugae Pattern Lesser Than 3mm Was 46.67% For 2mm And 3mm Among The Individuals .The Percentage Of Frequency Distribution Of Fragmented Rugae Was Found To Be 35% For 1mm And 2mm Dimensioned Rugae Respectively. The Percentage Of Frequency Distribution Of Secondary Rugae Patterns Greater Than 3mm Was Absent In 80% Of Participants Whereas 43.75% Individuals Had Secondary Rugae Patterns Of Dimension 2mm . 95% Of Participants Had A Unification Convergent Pattern, Whereas 55% Individuals Did Not Have A Unification Divergent Pattern. 30% Participants Had Class 1 Normal Occlusion Whereas 15% Had Class 3 Subdivision,15% Had Class 1 Malocclusion (Crowding) And 25% Had Class 2 Division 1 . Association Between Classes Of Occlusion And Gender Showed The Majority Of The Class 1 Normal Occlusion (24%) Among Female Participants Than Male Participants Which Was Not Statistically Significant With P Value 0.410 (>0.05) (Figure 1). Correlation Was Determined Between Curved Rugae Pattern And Occlusion Which Showed The Majority Of The Class 1 Normal Occlusion (25%) Had Curved Rugae Pattern Than Malocclusion. Pearson's Chi Square Test Shows P Value Is 0.023(<0.05). Hence It Is Statistically Significant (Figure 2). Association Between The Classes Of Occlusion And Fragmented Rugae Pattern Which Showed The Majority Of The Class 1 Normal Occlusion (20%) Had Two Fragmented Rugae Patterns Than Malocclusion With P Value 0.047(<0.05). Hence It Is Statistically Significant (Figure 2).

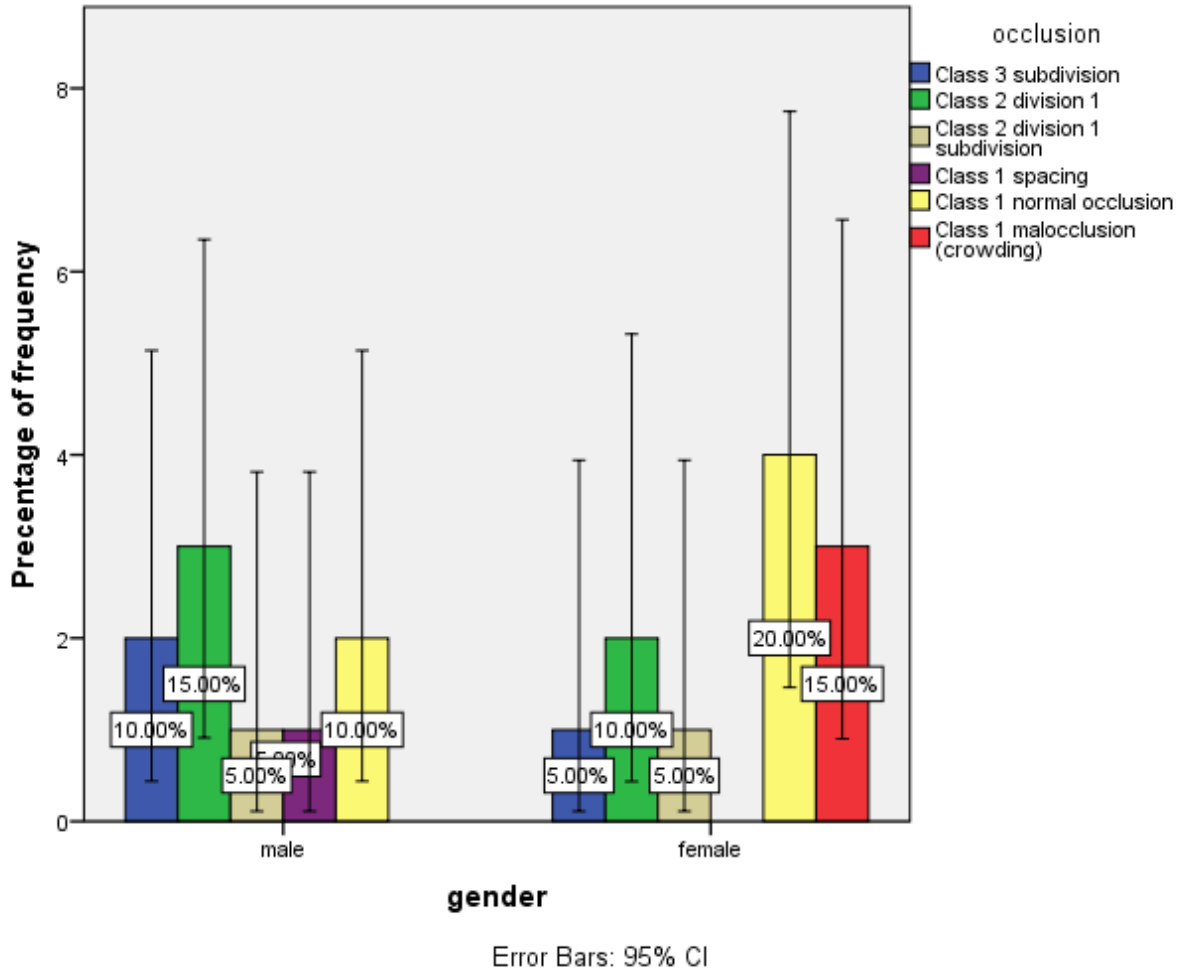


Figure 1: The Bar Graph Represents The Percentage Distribution Of Classes Of Occlusion Association Between Male And Female. The X-Axis Represents The Gender And The Y-Axis Represents The Frequency Of Distribution Of Occlusion. Blue Denotes Class 3 Subdivision, Green Denotes Class 2 Division 1, Beige Denotes Class 2 Division 1, Purple Denotes Class 1 Spacing, Yellow Denotes Class 1 Normal Occlusion And Red Denotes Class 1 Malocclusion. Majority Of The Class 1 Normal Occlusion (20%) Was Seen Among Female Participants Than Male Participants. The Difference Is Statistically Not Significant (Chi Square Test; P Value = 0.410- Statistically Not Significant) .

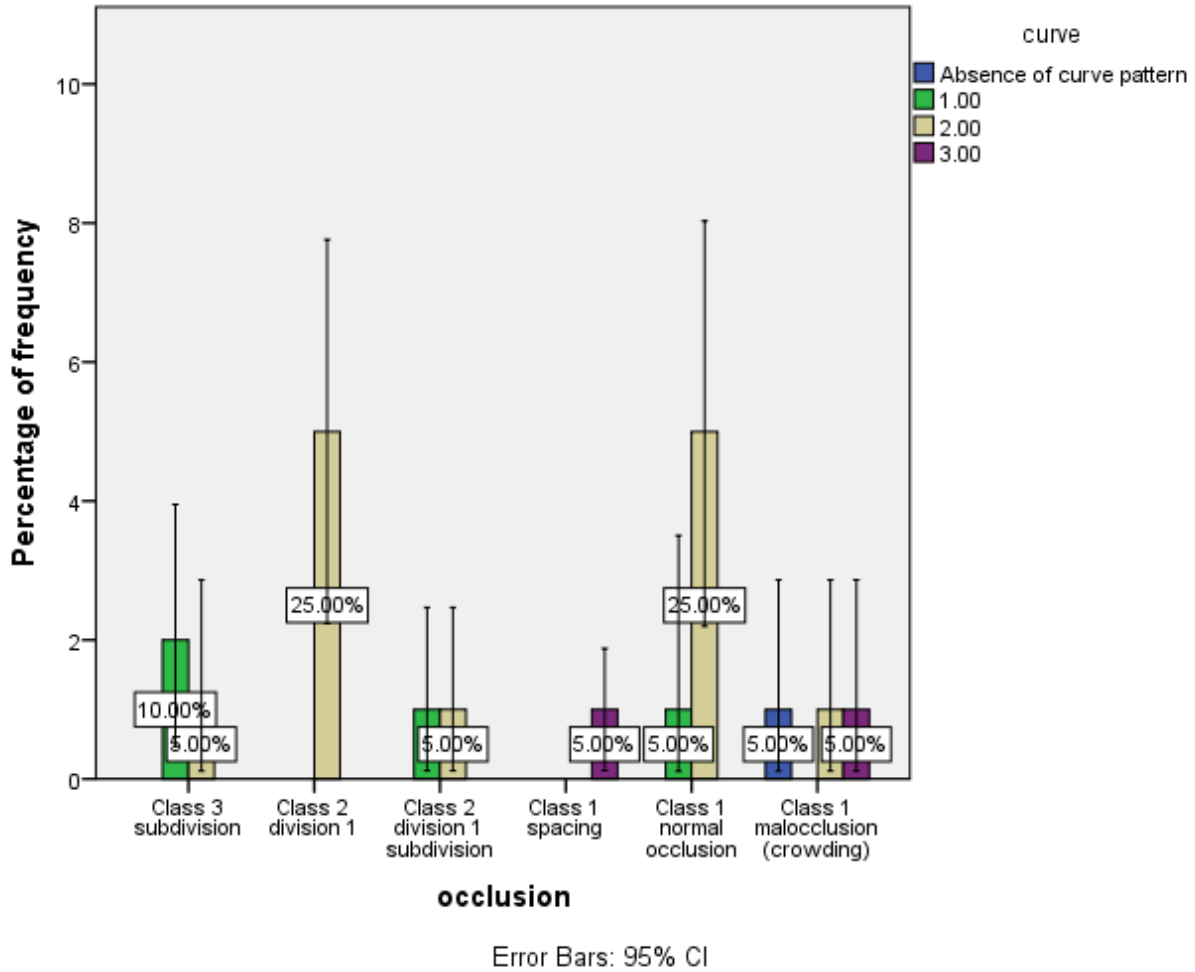


Figure 2: The Bar Graph Represents The Frequency Distribution Of Classes Of Occlusion Associated With Curved Rugae Pattern. The X-Axis Represents The Occlusion And The Y-Axis Represents The Percentage Of Curved Rugae Patterns. Blue Denotes Absence Of Curved Rugae, Green Denotes One Curved Rugae Pattern, Beige Denotes Two Curved Rugae Patterns And Purple Denotes Three Curved Rugae Patterns. Majority Of The Class 1 Normal Occlusion And Class 2 Division 1 (25%) Had Two Curved Rugae Patterns Than Malocclusion. The Difference Is Statistically Significant (Chi Square Test; P Value = 0.023 - Statistically Significant) .

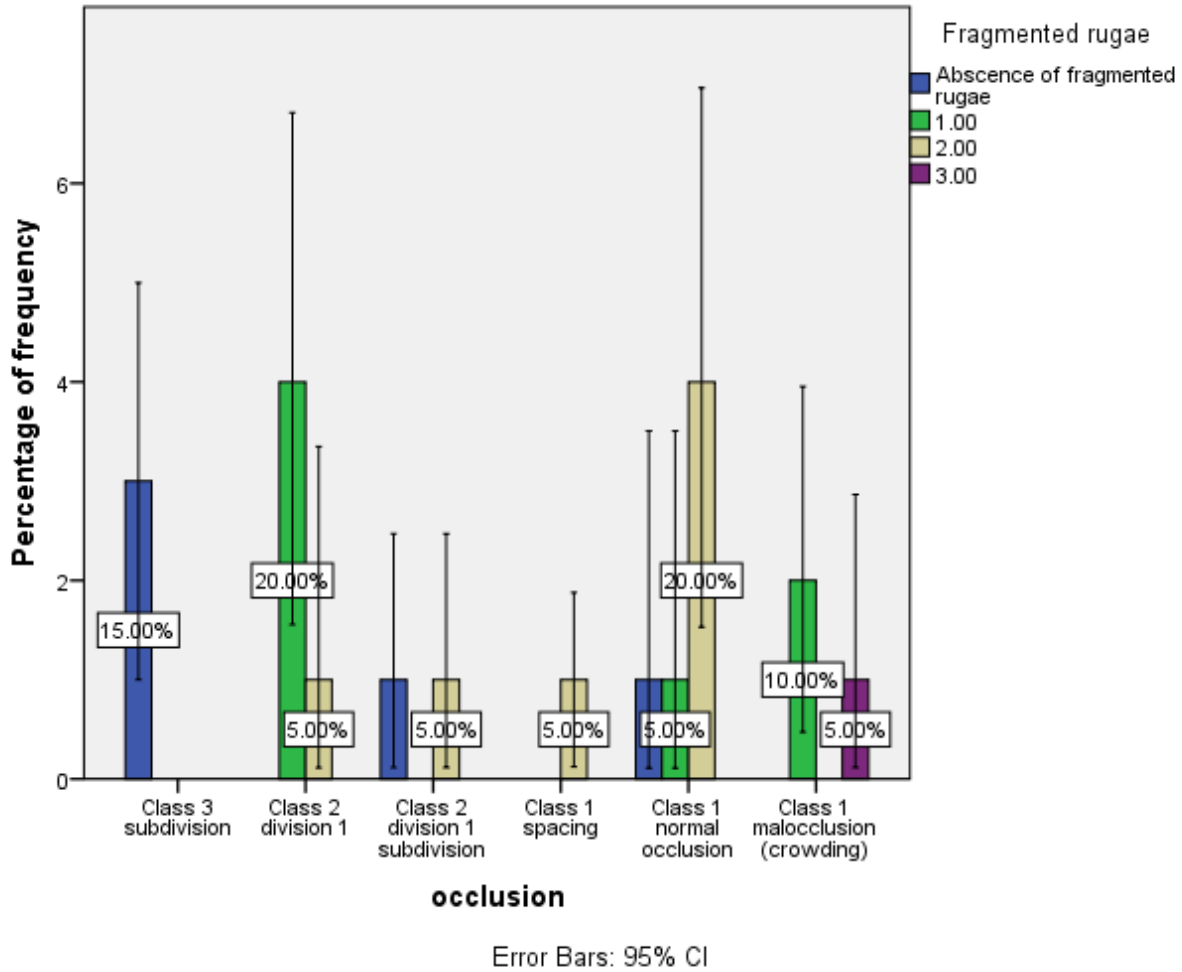


Figure 3: The Bar Graph Represents The Frequency Distribution Of Classes Of Occlusion Associated With Fragmented Rugae Patterns. The X-Axis Represents The Occlusion And The Y-Axis Represents The Percentage Of Fragmented Rugae Patterns. Blue Denotes Absence Of Fragmented Rugae, Green Denotes One Fragmented Rugae Pattern, Beige Denotes Two Fragmented Rugae Pattern And Purple Denotes Three Fragmented Rugae Patterns. Majority Of The Class 1 Normal Occlusion (20%) Had Two Fragmented Rugae Patterns Than Malocclusion. Pearson’s Chi Square Test Shows P Value Is 0.047(<0.05). Hence It Is Statistically Significant.

Discussion :

The Results Suggest That In Individuals The Maximum Number Of Rugae Were Seen Among Men with Mean Value 70. Based On The Occlusion Dominating Pattern Was Fragmented Rugae (20%) And Curve (25%) Whereas In Malocclusion The More Predominant Pattern Was Primary And Wavy. Based On Gender Wavy (Mean-27) And Secondary Rugae (Mean- 32) Was Predominantly Found For Females Whereas In Males Primary Rugae (Mean-28) And Wavy

(Mean- 31) Was Found Predominant. Accordingly The Most Predominant Pattern Observed Among The Individuals Was Secondary Rugae (Mean- 55) And Wavy (Mean- 58).

Palatal Rugae Patterns Are Unique For Every Individual As Per Previous Studies Done By Gaikwad R Et Al., 2019 Reported That Rugae Pattern Helps In Significant Determination Of Sexual Dimorphism (33) Which Is Contraindicated Based On Current Study As Males And Females Have Predominant Primary Rugae Pattern And Secondary Rugae Pattern Without Any Statistical Significance Whereas The Author Farheen Fathima Et Al., 2019 Declared That The Association Of Palatal Rugae Patterns With Gender Determination Did Not Have Any Statistical Significance Which Is Related To The Results Of Present Study But The Current Study Had Reported The Predominance Of Pattern Based On Gender Which Was Lacking In Previous Literature (34).The Other Study States That The Rugae Pattern Had Significance Difference With Sex Determination Based On Palatal Rugae Patterns Classification Which Is Controversial To Results Of The Present Study (33) .

In The Current Study Majority Of Rugae Patterns Were Found Among Class 1 Normal Occlusion Individuals Than Malocclusion Which Was Also Found In Study Done By Farheen Fathima Et Al., 2019. Similarly Kapoor Et Al., States That The Mean Palatal Rugae Was Greater Among Class 1 Normal Occlusion Than Other Four Malocclusions (35).

The Present Study Had Determined The Parameters Based On Kapali And Thomas And Kotze Classifications Whereas Murdoch Am Et Al., 2009 (36) And Gondivkar Et Al., 2011(37) Had Determined Only Gender With Palatal Rugae Pattern Or By The Usage Of Any Of The Rugae Pattern Classification. Hence This Study Had Determined The Kapali's Classification, Thomas And Kotze Classification And Gender Determination Among The Individuals Which Makes It A Unique Study As Previous Studies Had Not Considered All Together.

The Limitations Of The Study Are Less Sample Size, Error On Measurement Or Error On Entry Of Data, Inclusion Of More Criterias Etc.Hence More Studies Has To Be Done To Generalize The Results Wheres The Future Scope Of The Study Is That Depending On The Predominance Of Pattern The Malocclusion Can Be Determined Prior And Given A Prior Treatment To Control The Prevalence And Gender Determination Can Be Determined If More Sample Are Added And Significance Are Achieved.

Conclusion

The Findings Of The Study Suggests Significant Difference In The Classes Of Occlusion Between Curved And Fragmented Rugae Patterns Will Help In Prior Determination Of Different Occlusion And Based On The Occlusion Dominating Pattern Was Fragmented Rugae And Curve Whereas In Malocclusion More Predominant Pattern Was Primary And Wavy. Based On Gender Wavy And Secondary Rugae Was Predominantly Found For Females Whereas In Males Primary Rugae And Wavy Was Found Predominant. Accordingly The Most Predominant Pattern

Observed Among The Individuals Was Secondary Rugae And Wavy. Hence More Studies Have To Be Done To Generalize The Results.

Acknowledgement:

We Thank Saveetha Dental College For Providing Us The Support To Conduct The Study.

Conflict Of Interest:

The Author Declares That There Was No Conflict Of Interest In The Present Study.

Funding Source:

The Present Study Was Supported By The Following Agencies.

- Saveetha Dental College
- Simats, Saveetha University
- Tancreative Company

References:

1. Sarode Sc, Augustine J, Sarode G, Gopalakrishnan D, Patil S. Perspective On Forensic Odontology And Covid-19. J Contemp Dent Pract. 2020 Aug 1;21(8):819–21.
2. Ginart Mt. Assessment Of Palatal Rugae In A Multiethnic Population [Internet]. Available From: [Http://Dx.Doi.Org/10.17077/Etd.005344](http://Dx.Doi.Org/10.17077/Etd.005344)
3. El-Banna As, Al-Rousan M, Abu-Sheasha G. A Study Of Palatal Rugae Patterns And Maxillary Inter-Canine Distance In A Jordanian Population Sample [Internet]. Vol. 1, Arab Journal Of Forensic Sciences & Forensic Medicine. 2019. P. 1196–209. Available From: [Http://Dx.Doi.Org/10.26735/16586794.2019.007](http://Dx.Doi.Org/10.26735/16586794.2019.007)
4. Armstrong J, Seehra J, Andiappan M, Jones Ag, Papageorgiou Sn, Cobourne Mt. Palatal Rugae Morphology Is Associated With Variation In Tooth Number. Sci Rep. 2020 Nov 5;10(1):19074.
5. Pazera C, Gkantidis N. Palatal Rugae Positional Changes During Orthodontic Treatment Of Growing Patients. Orthod Craniofac Res [Internet]. 2020 Nov 17; Available From: [Http://Dx.Doi.Org/10.1111/Ocr.12441](http://Dx.Doi.Org/10.1111/Ocr.12441)
6. Patil Ms, Patil Sb, Acharya Ab. Palatine Rugae And Their Significance In Clinical Dentistry: A Review Of The Literature. J Am Dent Assoc. 2008 Nov;139(11):1471–8.
7. Alshahrani I, Syed S, Dawasaz Aa, Togoo Ra, Addas Mk, Assaf A. Developmental Association Of Palatal Dimensions And Palatal Rugae Characteristics In Angle’S Classes I,

- Ii And Iii Of Malocclusion [Internet]. Vol. 37, International Journal Of Morphology. 2019. P. 744–51. Available From: [Http://Dx.Doi.Org/10.4067/S0717-95022019000200744](http://Dx.Doi.Org/10.4067/S0717-95022019000200744)
8. Saxena E, Hongal S, Torwane N, Mishra P, Chandrashekhar Br, Goel P. A Study Of The Palatal Rugae Pattern Among Male Female And Transgender Population Of Bhopal City [Internet]. Vol. 7, Journal Of Forensic Dental Sciences. 2015. P. 142. Available From: [Http://Dx.Doi.Org/10.4103/0975-1475.146370](http://Dx.Doi.Org/10.4103/0975-1475.146370)
 9. J.A.S., J. As. Plicae Palatinae Transversae And Papilla Incisiva In Man. A Morphologic And Genetic Study [Internet]. Vol. 41, American Journal Of Orthodontics. 1955. P. 879–80. Available From: [Http://Dx.Doi.Org/10.1016/0002-9416\(55\)90193-7](http://Dx.Doi.Org/10.1016/0002-9416(55)90193-7)
 10. Bené De Oliveira Me, Borba Da Rocha Cordeiro N, De Andrade Veras Sr, Costa De Melo Em, Viana Do Vale Dm, França Gurgel Lg, Et Al. Malocclusion In Children Aged 8 To 10 Years Old With Operated Isolated Cleft Palate. *J Craniofac Surg.* 2021;32(2):E156–9.
 11. Shetty D, Juneja A, Jain A, Khanna Ks, Pruthi N, Gupta A, Et Al. Assessment Of Palatal Rugae Pattern And Their Reproducibility For Application In Forensic Analysis. *J Forensic Dent Sci.* 2013 Jul;5(2):106–9.
 12. Rajan Vp, John Jb, Stalin A, Priya G, Abuthagir Aks. Morphology Of Palatal Rugae Patterns Among 5-15 Years Old Children. *J Pharm Bioallied Sci.* 2013 Jun;5(Suppl 1):S43–7.
 13. Sekar D, Lakshmanan G, Mani P, Biruntha M. Methylation-Dependent Circulating Microrna 510 In Preeclampsia Patients. *Hypertens Res.* 2019 Oct;42(10):1647–8.
 14. Princeton B, Santhakumar P, Prathap L. Awareness On Preventive Measures Taken By Health Care Professionals Attending Covid-19 Patients Among Dental Students. *Eur J Dent.* 2020 Dec;14(S 01):S105–9.
 15. Logeshwari R, Rama Parvathy L. Generating Logistic Chaotic Sequence Using Geometric Pattern To Decompose And Recombine The Pixel Values. *Multimed Tools Appl.* 2020 Aug;79(31-32):22375–88.
 16. Johnson J, Lakshmanan G, M B, R M V, Kalimuthu K, Sekar D. Computational Identification Of Mirna-7110 From Pulmonary Arterial Hypertension (Pah) Ests: A New Microrna That Links Diabetes And Pah. *Hypertens Res.* 2020 Apr;43(4):360–2.
 17. Paramasivam A, Priyadharsini Jv, Raghunandhakumar S, Elumalai P. A Novel Covid-19 And Its Effects On Cardiovascular Disease. *Hypertens Res.* 2020 Jul;43(7):729–30.
 18. Pujari Grs, Subramanian V, Rao Sr. Effects Of *Celastrus Paniculatus* Willd. And *Sida*

- Cordifolia Linn. In Kainic Acid Induced Hippocampus Damage In Rats. *Ind J Pharm Educ.* 2019 Jul 3;53(3):537–44.
19. Rajkumar Kv, Lakshmanan G, Sekar D. Identification Of Mir-802-5p And Its Involvement In Type 2 Diabetes Mellitus. *World J Diabetes.* 2020 Dec 15;11(12):567–71.
 20. Ravisankar R, Jayaprakash P, Eswaran P, Mohanraj K, Vinitha G, Pichumani M. Synthesis, Growth, Optical And Third-Order Nonlinear Optical Properties Of Glycine Sodium Nitrate Single Crystal For Photonic Device Applications. *J Mater Sci: Mater Electron.* 2020 Oct;31(20):17320–31.
 21. Wu S, Rajeshkumar S, Madasamy M, Mahendran V. Green Synthesis Of Copper Nanoparticles Using *Cissus Vitifolia* And Its Antioxidant And Antibacterial Activity Against Urinary Tract Infection Pathogens. *Artif Cells Nanomed Biotechnol.* 2020 Dec;48(1):1153–8.
 22. Vikneshan M, Saravanakumar R, Mangaiyarkarasi R, Rajeshkumar S, Samuel Sr, Suganya M, Et Al. Algal Biomass As A Source For Novel Oral Nano-Antimicrobial Agent. *Saudi J Biol Sci.* 2020 Dec;27(12):3753–8.
 23. Alharbi Ks, Fuloria Nk, Fuloria S, Rahman Sb, Al-Malki Wh, Javed Shaikh Ma, Et Al. Nuclear Factor-Kappa B And Its Role In Inflammatory Lung Disease. *Chem Biol Interact.* 2021 Aug 25;345:109568.
 24. Rao Sk, Kalai Priya A, Manjunath Kamath S, Karthick P, Renganathan B, Anuraj S, Et Al. Unequivocal Evidence Of Enhanced Room Temperature Sensing Properties Of Clad Modified Nd Doped Mullite Bi₂Fe₄O₉ In Fiber Optic Gas Sensor [Internet]. Vol. 838, *Journal Of Alloys And Compounds.* 2020. P. 155603. Available From: [Http://Dx.Doi.Org/10.1016/J.Jallcom.2020.155603](http://dx.doi.org/10.1016/j.jallcom.2020.155603)
 25. Bhavikatti Sk, Karobari Mi, Zainuddin Sla, Marya A, Nadaf Sj, Sawant Vj, Et Al. Investigating The Antioxidant And Cytocompatibility Of *Mimusops Elengi* Linn Extract Over Human Gingival Fibroblast Cells. *Int J Environ Res Public Health* [Internet]. 2021 Jul 4;18(13). Available From: [Http://Dx.Doi.Org/10.3390/Ijerph18137162](http://dx.doi.org/10.3390/ijerph18137162)
 26. Marya A, Karobari Mi, Selvaraj S, Adil Ah, Assiry Aa, Rabaan Aa, Et Al. Risk Perception Of Sars-Cov-2 Infection And Implementation Of Various Protective Measures By Dentists Across Various Countries. *Int J Environ Res Public Health* [Internet]. 2021 May 29;18(11). Available From: [Http://Dx.Doi.Org/10.3390/Ijerph18115848](http://dx.doi.org/10.3390/ijerph18115848)
 27. Barma Md, Muthupandiyani I, Samuel Sr, Amaechi Bt. Inhibition Of *Streptococcus Mutans*, Antioxidant Property And Cytotoxicity Of Novel Nano-Zinc Oxide Varnish. *Arch Oral*

Biol. 2021 Jun;126:105132.

28. 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):1441–8.
29. Priyadharsini Jv, Vijayashree Priyadharsini J, Smiline Girija As, Paramasivam A. In Silico Analysis Of Virulence Genes In An Emerging Dental Pathogen *A. Baumannii* And Related Species [Internet]. Vol. 94, *Archives Of Oral Biology.* 2018. P. 93–8. Available From: [Http://Dx.Doi.Org/10.1016/J.Archoralbio.2018.07.001](http://dx.doi.org/10.1016/j.archoralbio.2018.07.001)
30. Uma Maheswari Tn, Nivedhitha Ms, Ramani P. Expression Profile Of Salivary Micro Rna-21 And 31 In Oral Potentially Malignant Disorders. *Braz Oral Res.* 2020 Feb 10;34:E002.
31. Gudipani Rk, Alam Mk, Patil Sr, Karobari Mi. Measurement Of The Maximum Occlusal Bite Force And Its Relation To The Caries Spectrum Of First Permanent Molars In Early Permanent Dentition. *J Clin Pediatr Dent.* 2020 Dec 1;44(6):423–8.
32. Chaturvedula Bb, Muthukrishnan A, Bhuvaraghan A, Sandler J, Thiruvengkatachari B. Dens Invaginatus: A Review And Orthodontic Implications. *Br Dent J.* 2021 Mar;230(6):345–50.
33. Saraf A, Bedia S, Indurkar A, Degwekar S, Bhowate R. Rugae Patterns As An Adjunct To Sex Differentiation In Forensic Identification. *J Forensic Odontostomatol.* 2011 Jul 1;29(1):14–9.
34. Fatima F, Fida M, Shaikh A. The Association Between Palatal Rugae Pattern And Dental Malocclusion. *Dental Press J Orthod.* 2019 Jan;24(1):37e1–37e9.
35. Kapoor P. Rugoscopy: A Diagnostic Appurtenance For Malocclusion Or Just A Forensic Aid? - A Pilot Study [Internet]. Vol. 06, *Journal Of Forensic Research.* 2015. Available From: [Http://Dx.Doi.Org/10.4172/2157-7145.1000272](http://dx.doi.org/10.4172/2157-7145.1000272)
36. Murdoch Am, Patir A, Seymen F, Vieira Ar. Studies Of Palatine Rugae And Interferon Regulatory Factor 6 Variations In A Group Of Families With Sporadic Hypodontia [Internet]. Vol. 51, *Journal Of Oral Science.* 2009. P. 521–6. Available From: [Http://Dx.Doi.Org/10.2334/Josnusd.51.521](http://dx.doi.org/10.2334/josnusd.51.521)
37. Gondivkar Sm, Patel S, Gadbail Ar, Gaikwad Rn, Chole R, Parikh Rv. Morphological Study Of The Palatal Rugae In Western Indian Population. *J Forensic Leg Med.* 2011 Oct;18(7):310–2.