

KNOWLEDGE AND AWARENESS ON DIFFERENCE BETWEEN MONOLITHIC AND HAND LAYERED CROWN AMONG DENTAL STUDENTS.

- **Revathi.B**

Undergraduate student Department of Prosthodontics, Saveetha Dental College, Saveetha Institute Of Medical And Technical Sciences, Saveetha University, Chennai, India.

- **Dhanraj M Ganapathy**

Professor and Head of Department, Department of Prosthodontics, Saveetha Dental College, Saveetha Institute Of Medical And Technical Sciences, Saveetha University, Chennai, India.

- **SubhabrataMaiti***

Assistant Professor Department of Prosthodontics, Department of Prosthodontics, Saveetha Dental College, Saveetha Institute Of Medical And Technical Sciences, Saveetha University, Chennai, India.

- **VenkateshKommi**

Assistant Professor Department of Prosthodontics, Saveetha Dental College, Saveetha Institute Of Medical And Technical Sciences, Saveetha University, Chennai, India.

ABSTRACT

Introduction: Recent advancements in zirconia based restorations extended the survival rate of fixed dental prosthesis and single crown to the next level. Both Monolithic and layered zirconia are highly preferred among prosthodontists for both anterior and posterior edentulous areas. Hence the assessment of differences between monolithic and hand layered crowns among dental students is significant to provide a high quality rehabilitation to the patients.

Aim: To assess the knowledge and awareness of the difference between monolithic and hand layered zirconia crowns among dental students.

Materials and methods: A total of 150 dental undergraduate students aged between 18-25 years were included in this study. A questionnaire based online survey was conducted using the link created in google forms. The responses were tabulated in excel sheets and imported to Statistical Package of Social Sciences version 17, IBM corporation.

Results: 68% of the students are aware that the monolithic crown has higher restoration strength than the hand layered crown. 82% of the dental students are aware that hand layered crowns have outstanding biocompatibility in the oral cavity. 76.6% of them are aware that hand layered zirconia has a superior aesthetic level. About 91.3% were aware that a hand layered crown is preferred for replacement of anterior teeth. 76.6% are aware that hand layered zirconia has more translucency and opalescence than monolithic zirconia. The percentage of knowledge and awareness was higher among intern students compared to third and fourth year undergraduate students (Significant association; chi square test- $p < 0.001$).

Conclusion: The awareness of the difference between monolithic and hand layered crowns is not adequate among dental students.

KEYWORDS: Awareness; Difference; Monolithic; Layered; Dental students, innovation.

INTRODUCTION:

All ceramic crown systems are recently developed for better esthetics, survival rate and mechanical strength. The demand is increasing to fulfill the above mentioned criteria among all standards of patients. The neglect of the removable or cast partial dentures and complete dentures due to their complexity and maintenance turned the attention towards all ceramic fixed crowns(1). Multiple ceramic crown systems are available along with glass ceramic such as lithium disilicate and oxide ceramics like zirconia and alumina. Excellent esthetic characteristics and optimal mechanical properties are mandatory for an ideal all-ceramic/metal ceramic material(2). The basic criterias such as flexural strength, fracture toughness and limited crack propagation at the functional and parafunctional load conditions ensure lifetime serviceability of any prosthetic dental material. This can be related to variations in chemical composition and their microstructure of each material(3).

Unlike any other dental materials, discovery of zirconia in the field of dentistry created a revolution among dentists especially prosthodontists due to its high fracture resistance and resemblance to natural teeth thereby gaining tremendous patient satisfaction(4). Zirconia has outstanding mechanical properties but has high opacity due to its crystalline microstructure thereby, the coping must be covered with veneering porcelain to attain a satisfactory esthetic outcome(5,6). However, in the field of prosthodontics, one of the major disadvantages of zirconia is fracture(7). Chipping of the zirconia originates from occlusal/contact loads which may later lead to fracture. Earlier studies reported that survival of zirconia based restorations is limited which can be due to influence of core design that aids in veneering ceramic and thickness of ceramic material(8). Hence this complication creates an uncertainty as regards the long-term clinical behavior of the zirconia bi-layered restorations. However, in recent times several techniques have been made to improvise the fracture strength of the veneering ceramic such as high strength CAD/CAM ceramic, press ceramic or double veneering(9–11).

Crowns which are made from lithium disilicate and aluminum oxide provide a high range of good long clinical outcomes therefore acts as the standard crowns for anterior teeth replacements(12). On considering the fracture resistance, these crowns fail to bear the occlusal loading. Whereas, the tendency of fracture strength is considerably higher in zirconia based restorations and attributed to a clinical outcome of more than 20 years on average(13).

Zirconia based crowns may be either monolithic or hand layered crowns. Many in vitro studies have been performed to analyze the specificities of monolithic and layered crowns. Undeniably, proper clinical trials provide us with accurate outcomes but it is time consuming and requires standardization. Even though multiple studies have been done in various aspects in terms of testing the loading ability and fracture resistance of zirconia crowns, enhanced treatment planning accounting to patient satisfaction is only in the hands of dentists(14–16). To our authors' knowledge, no previous studies have created awareness on monolithic and hand layered zirconia crowns among dental students. Our team has extensive knowledge and research experience that has translated into high quality publications (17–23),(24–38). Hence the aim of the current study is to analyze the knowledge and awareness on differences between monolithic and hand layered crowns among undergraduate dental students.

MATERIALS AND METHODS:

Study setting: The study was conducted with the approval of the Institutional Ethics committee. The study consisted of one reviewer, one assessor and one guide.

Study design: This study was designed to include 150 dental students aged between 18-25 years. The patients who did not fall into this category were excluded. They were categorised into three groups , that is BDS III year, IV year and intern going students.

Sampling technique: This study was a cross sectional survey. Questionnaire was created using the link in google forms. A total of 10 questions were asked in the questionnaire regarding the difference between monolithic and hand layered zirconia.

Statistical analysis : The data was imported and transcribed in Statistical Package for Social Science, version 17. Variables were compared using the chi square test. P less than or equal to 0.001 was considered statistically significant with a confidence interval of 95%.

RESULTS:

The result was explained through table 1 and figure 1-10.

| YEAR OF STUDY | Number of participants(%) |
|---------------|---------------------------|
| BDS III | 32(21.3%) |
| BDS IV | 64(42.7%) |
| Intern | 54(36%) |

Table 1 - Table shows the number of participants involved in this study.

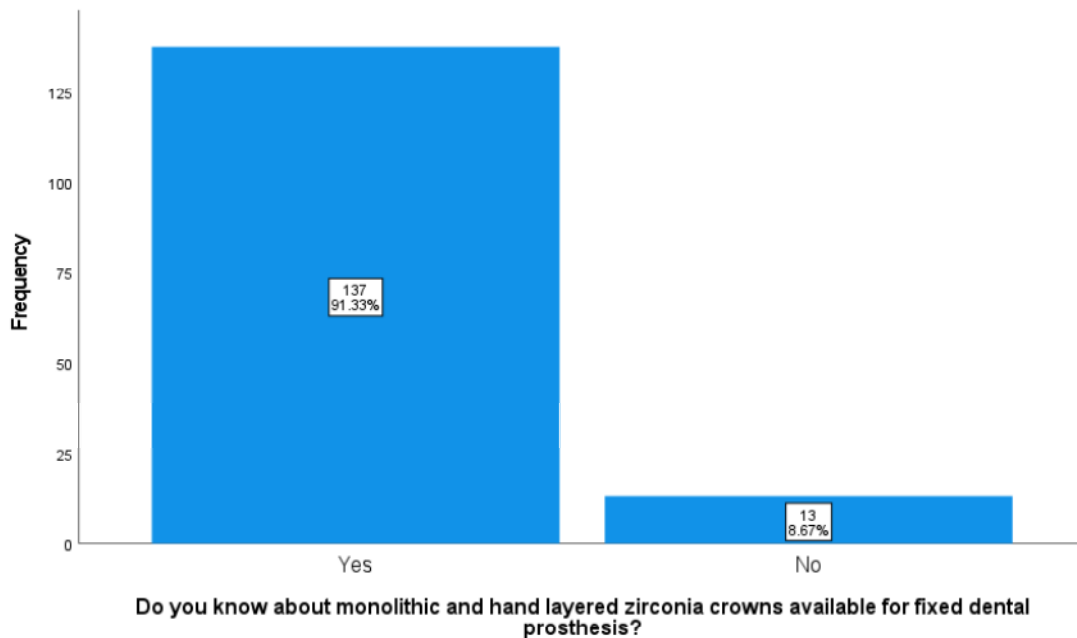


Figure 1- Graph represents the responses on awareness of monolithic and layered zirconia crowns for fixed dental prosthesis. 91.3% of them are aware of monolithic and hand layered zirconia and 8.6% of them are not aware of it

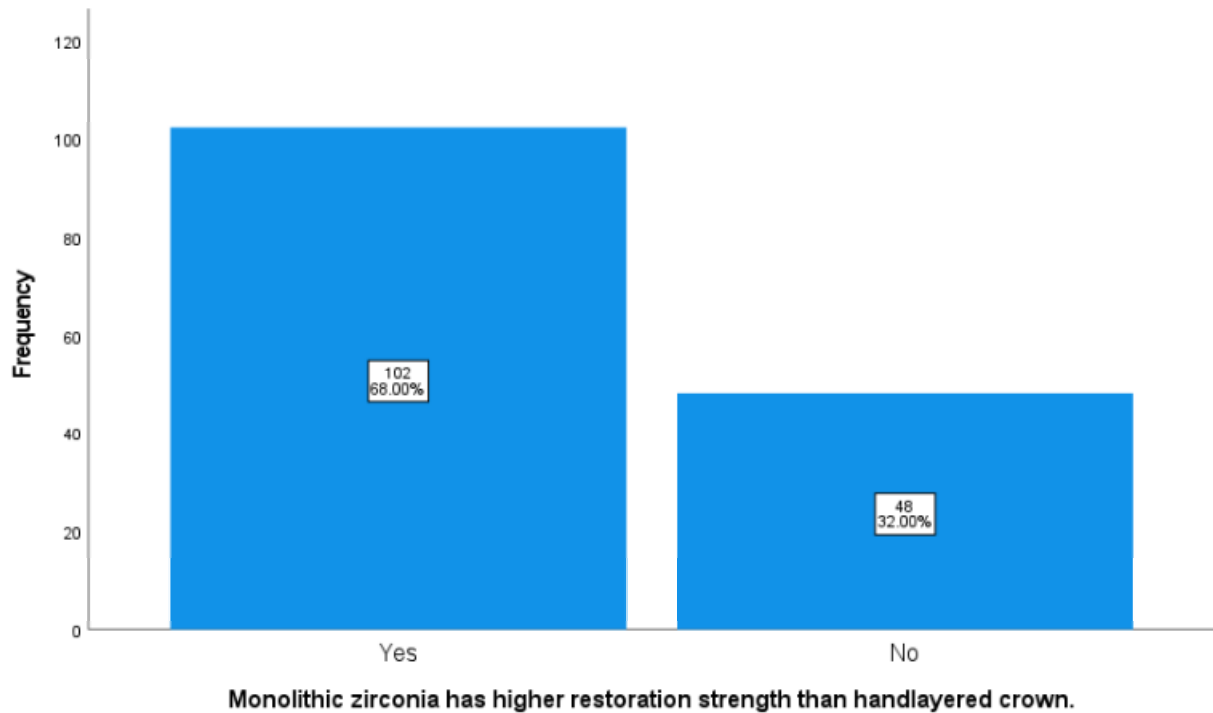


Figure 2 - Graph represents the responses on awareness of high restoration strength between monolithic zirconia and hand layered crown. About 68% of the students are aware that the monolithic crown has higher restoration strength than the hand layered crown.

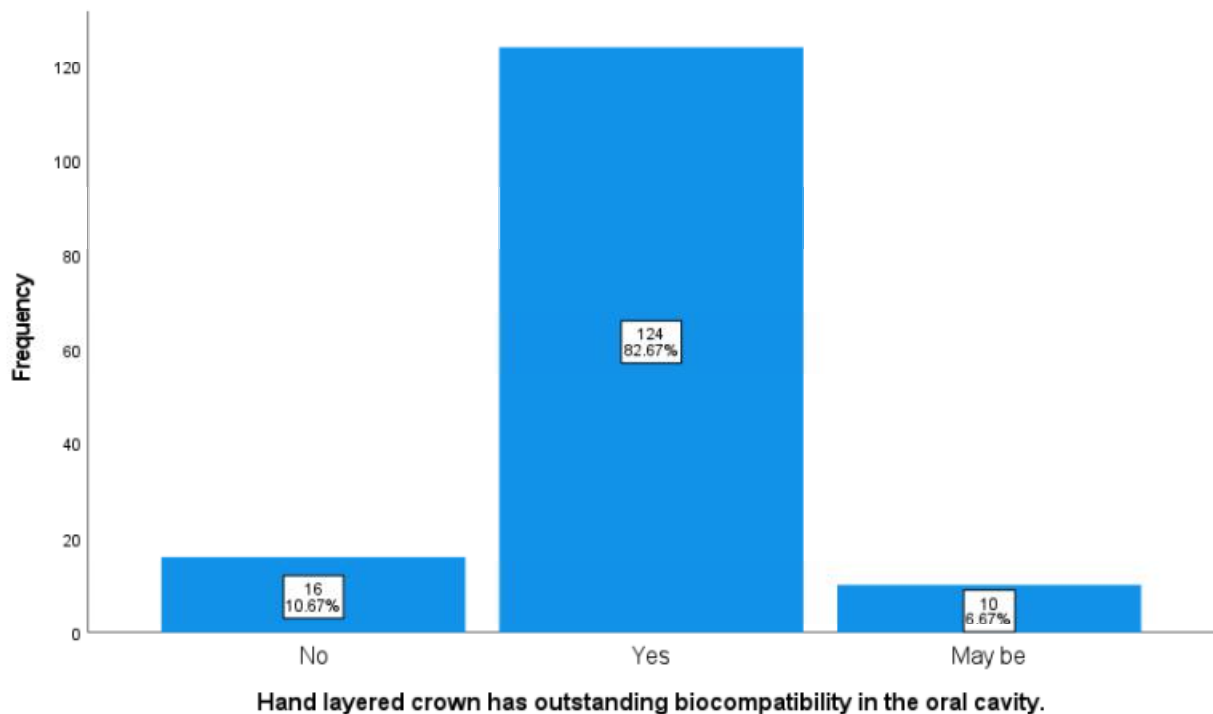


Figure 3- Graph shows the responses on awareness of outstanding biocompatibility of hand layered crown. 82% of the dental students are aware that hand layered crowns have outstanding biocompatibility in the oral cavity.

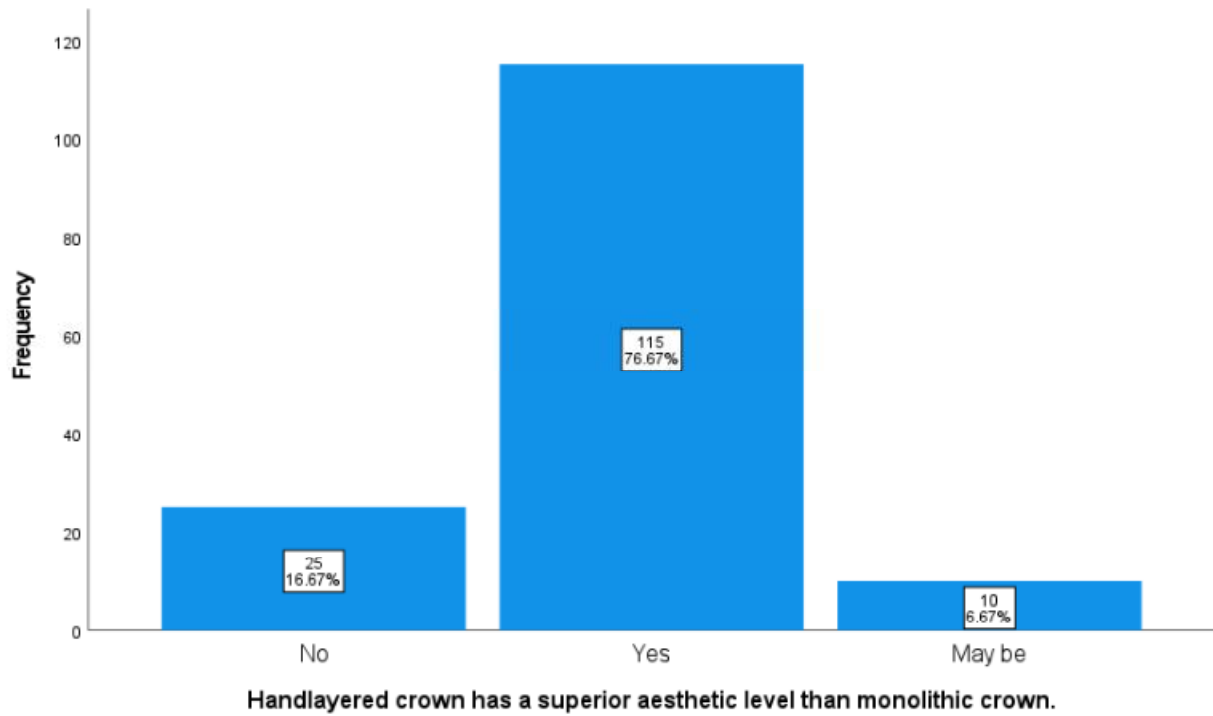


Figure 4- Graph shows the responses on awareness of superior aesthetic level of hand layered and monolithic crowns. About 76.6% of them are aware that hand layered zirconia has a superior aesthetic level and 16.6% of them are not aware of it.

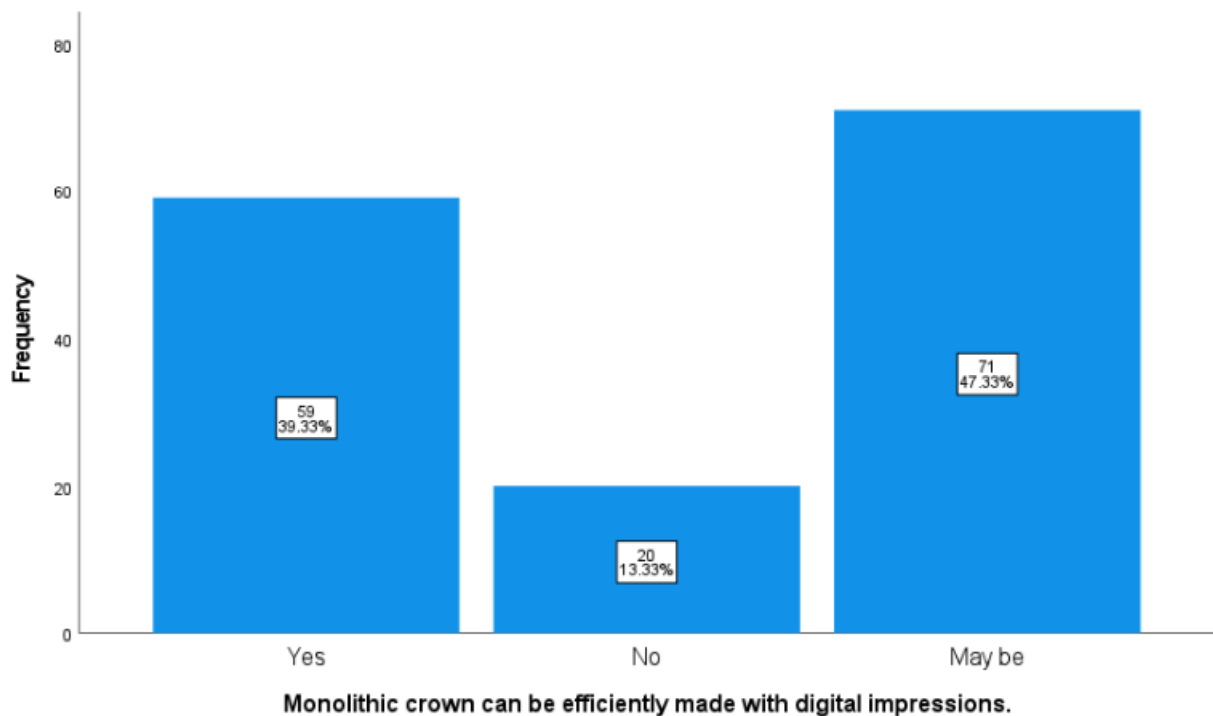


Figure 5 - Graph shows the responses on awareness of making digital impression efficiently using monolithic crowns. 39.3% of the participants are aware that monolithic crowns can be made efficiently using digital impressions, 13.3% are not aware and 47.3% are not sure whether monolithic crowns can be made efficiently using digital impressions.

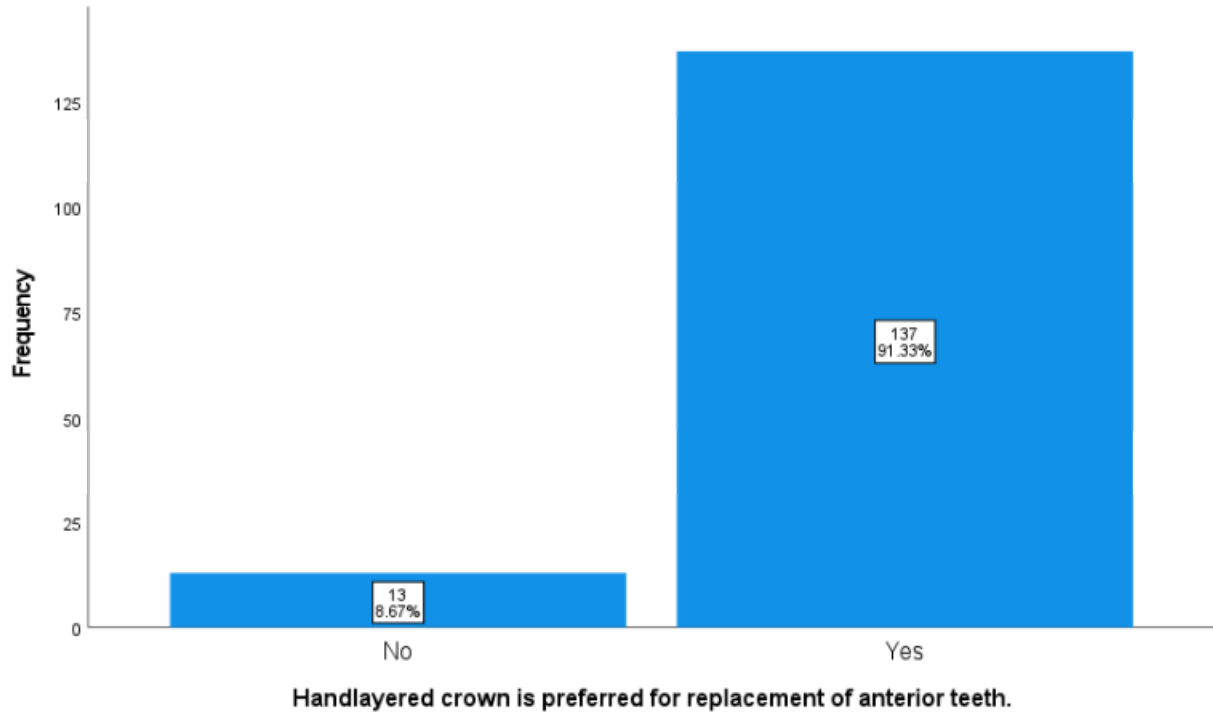


Figure 6- Graph shows the responses on awareness of preferring hand layered crowns for replacement of anterior teeth. About 91.3% of them are aware that a hand layered crown is preferred for replacement of anterior teeth and 8.6% of them were not aware of it.

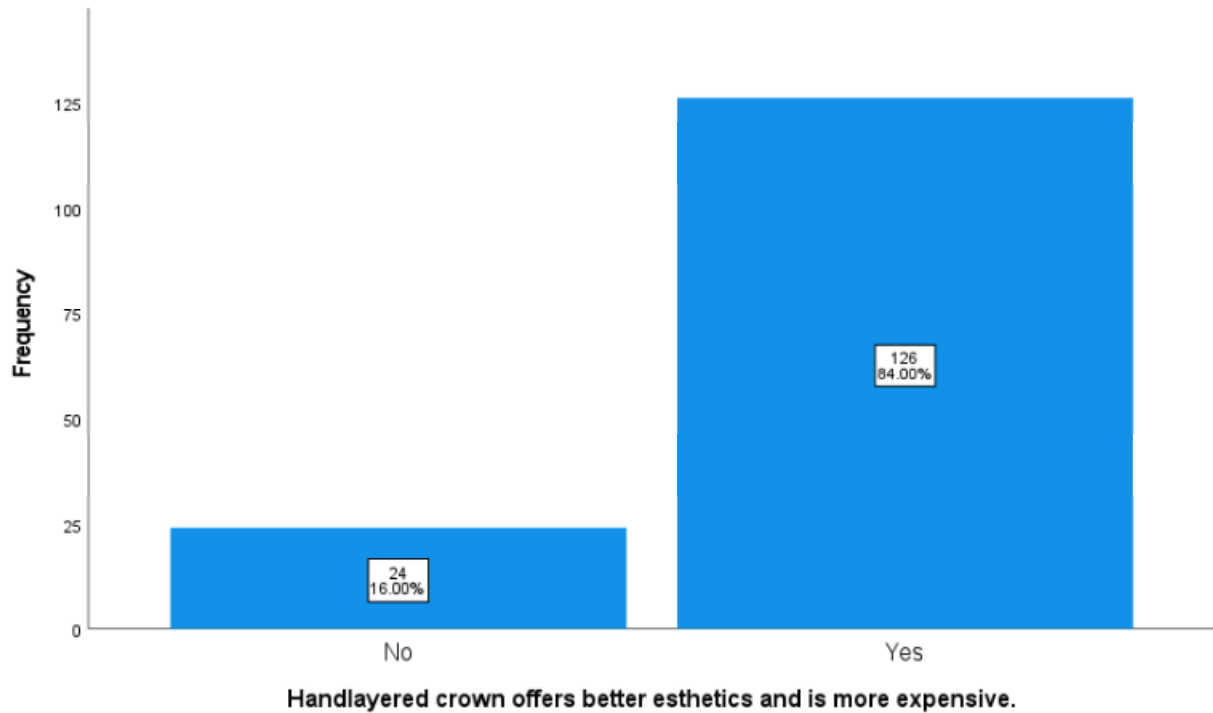


Figure 7 - Graph shows the responses on awareness of hand layered crowns with better aesthetics and expensive. 84% of the participants are aware that hand layered crown has better esthetics and are more expensive compared to monolithic zirconia and 16% of them are not aware of it.

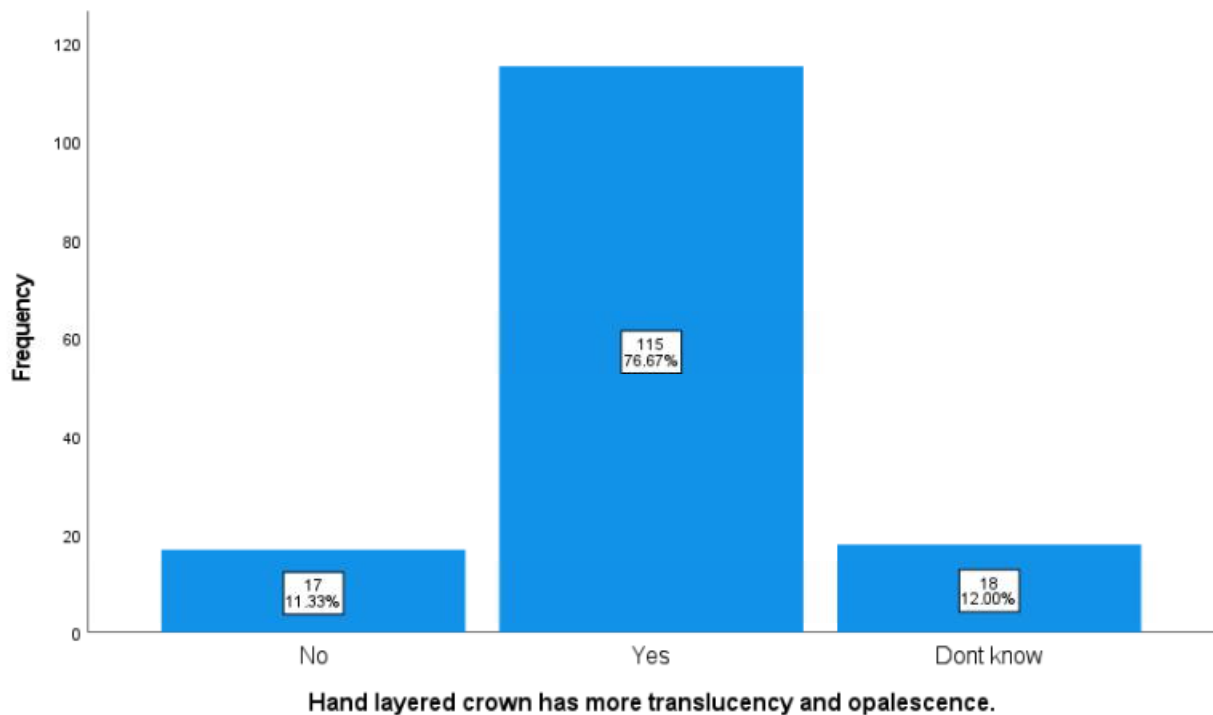


Figure 8- Graph shows the responses on awareness on hand layered crowns with more translucency and opalescence. About 76.6% are aware that hand layered zirconia has more translucency and opalescence than monolithic zirconia.

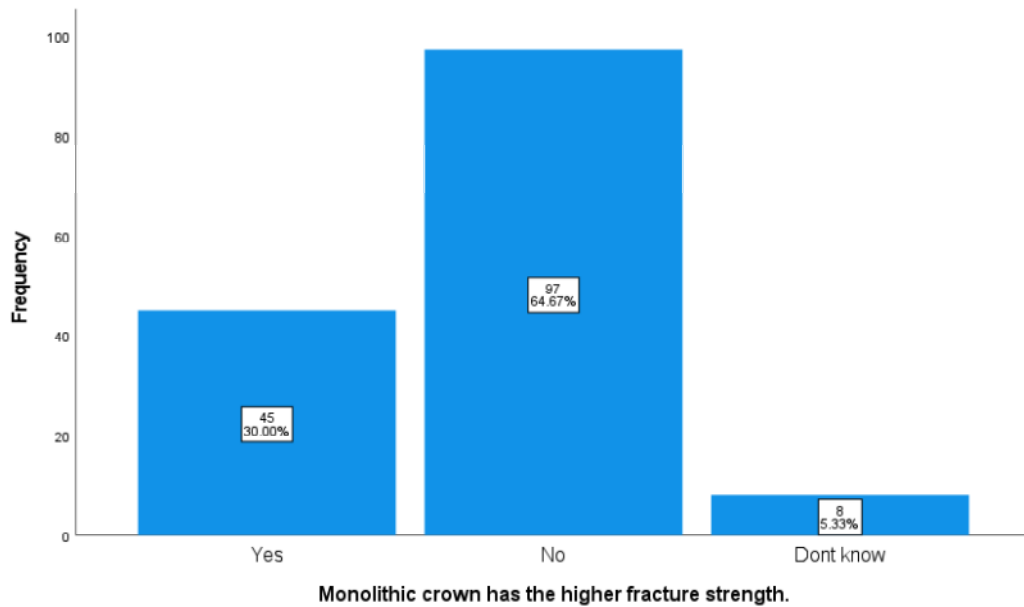


Figure 9- Graph shows the responses on awareness of monolithic crowns having higher fracture strength. 30% of the students are aware that monolithic zirconia has higher fracture strength than hand layered zirconia and 64.6% of them are not aware and 5.3% of the students are not sure of it.

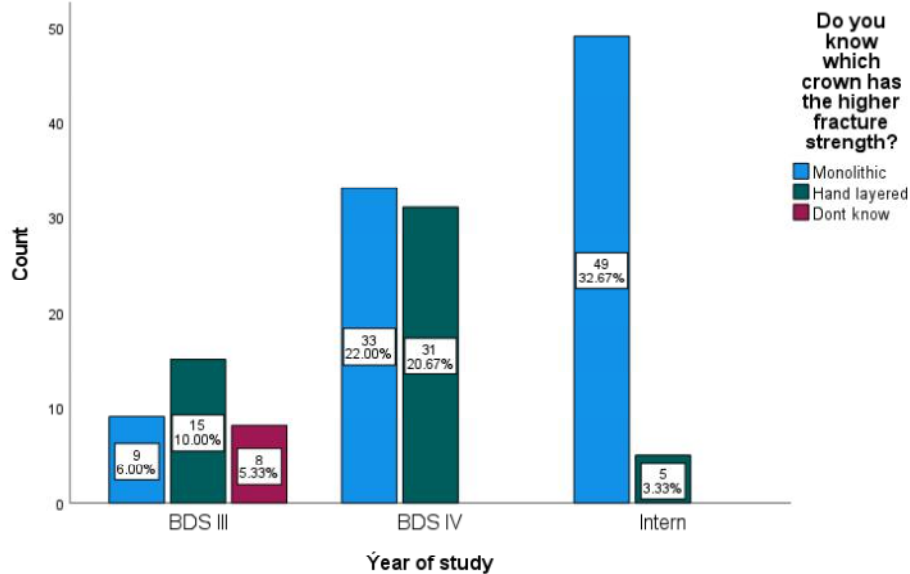


Figure 10- Graph shows the association between awareness of crown with higher fracture strength and year of study of dental students. Blue represents monolithic crown, green represents hand layered crown and red represents do not know. Significant correlation was found between year of study and knowledge on crown with higher fracture strength. Intern showed the highest correct response with monolithic zirconia compared to other years of study. Overall, the percentage of knowledge and awareness was higher among intern students compared to third and fourth year undergraduate students (Significant association; chi square test- $p < 0.001$).

DISCUSSION:

In the current study, most of the dental students are aware that monolithic zirconia has higher fracture and restoration strength compared to layered zirconia. The layered zirconia has a veneer surface that lacks the stress distribution and occlusal loading ability thereby leading to less fracture resistance. Fullmetal restorations was once a gold standard material of choice in dentistry, which is now replaced by layered zirconia due to emerging expensive prosthetic material and patients' high demand on esthetics, which could make profitability an important aspect in the dentists' decision on crown material(39,40). But in the current study, nearly 84% of the dental students are not even aware that layered crowns have better aesthetics and are more expensive, which proves that they do not have sufficient knowledge.

A study conducted by Majeed et al., reported that in a clinical trial of 5 years, the layered crown has less fracture resistance than monolithic zirconia with a rate 3.25%(41). Monolithic zirconia has excellent mechanical properties for dental use, but whether it is a durable material for conventional fixed prosthetic restorations over the long term is unclear. A study proved monolithic reinforced glass-ceramics (lithium disilicate and zirconia reinforced lithium silicate) have better fracture resistance than bilayered zirconia based ceramics(42) and also the fatigue load-to-failure of monolithic showed higher values than veneered Y-TZP crowns(43). Hence the use of monolithic zirconia is preferred over bi-layered to avoid chipping of the veneer surface. The fracture occurs especially at the connector site of the prosthesis(44). In a study conducted by Pihlaja et al., stated that the success rate of the zirconia-based partial FDPs after 4.9 years was 89%, and the survival rate was 100%(45).

Considering the biocompatibility, Hand layered crown has better biocompatibility than monolithic and it is known by 82% of the dental students in the present study. Metal ceramic crowns have limited biocompatibility compared to layered crown. Due to the addition of glass ceramic known as Feldspathic, which gives the excellent similarity to natural teeth and hence preferred more in anterior teeth(46). In general, the zirconium framework is three times higher than other ceramic materials, therefore offering good biocompatibility. Zirconia layered with a translucent ceramic, such as porcelain also is considered a more esthetic crown option, but the relatively low coefficient of thermal expansion and thermal diffusivity of zirconia compared to traditional metal coping materials led to laboratory complications such as veneer chipping and delamination(47–49).

Though the core design of both monolithic and layered crowns determines the fracture resistance, biocompatibility and aesthetics, the precise decision of planning the crown material according to each patient is essential. Previous study conducted by Habib et al., proved that the cementation process also influenced the fit of the Zr copings and the addition of vent-holes on the occlusal surface improved the fit(50). In my opinion , it is also in the hands of budding dentists that plays a vital role in the survival rate of monolithic and hand layered crowns in all clinical situations for which they must be aware of the basics of monolithic and hand layered crowns.

CONCLUSION:

From the study, the awareness of the difference between monolithic and hand layered crowns is not adequate among dental students. The primary factor to gain knowledge in this field is by making clinical judgment on the basis of evidence based approach to selecting a crown material. Any budding dental student must develop interest in the varied availability of the crown material and its characteristics, which ultimately paves way for the satisfactory outcome to the patients.

REFERENCES:

1. Shah S, Nallaswamy D, Ganapathy D. Marginal Accuracy of Milled Versus Cast Cobalt Chromium Alloys in Long Span Implant-Supported Frameworks: A Systematic Review and Meta-analysis. *Journal of Advanced Oral Research*. 2020 Nov 1;11(2):120–7.
2. Shenai A, Ganapathy D, Gounder R. All ceramic systems in dentistry. *Drug Invention Today* [Internet]. 2020; Available from: <http://search.ebscohost.com/login.aspx?direct=true&profile=ehost&scope=site&authtype=crawler&jrnl=09757619&AN=144741299&h=dYs3C0bty%2F0cB3fd2vvXnR0koFvzxrRHJWXWdQqF8eHZHXdUd88lnw4pYHYonH6OZcn9EXFH3hUAXJytpMh4OQ%3D%3D&crl=c>
3. Addison O, Marquis PM, Fleming GJP. Resin Elasticity and the Strengthening of All-ceramic Restorations [Internet]. Vol. 86, *Journal of Dental Research*. 2007. p. 519–23. Available from: <http://dx.doi.org/10.1177/154405910708600606>
4. Stawarczyk B, Keul C, Eichberger M, Figge D, Edelhoff D, Lümke N. Three generations of zirconia: From veneered to monolithic. Part I. *Quintessence Int*. 2017;48(5):369–80.
5. Raigrodski AJ, Hillstead MB, Meng GK, Chung K-H. Survival and complications of zirconia-based fixed dental prostheses: a systematic review. *J Prosthet Dent*. 2012 Mar;107(3):170–7.
6. Thamemul Ansari KA, Ganapathy D, Kiran K. Awareness of ceramic implants among dentists in Chennai. *Drug Invention Today* [Internet]. 2020;14(6). Available from: <http://search.ebscohost.com/login.aspx?direct=true&profile=ehost&scope=site&authtype=crawler&jrnl=09757619&AN=144741278&h=eRnrBfKMdeuZscAXjYYkBs0pB0dJo7v%2BAiXzI%2Bs68Gr%2B%2BfClbSkIyr8yiYzCTBgYxh8GBYd6r2P7yzllQTxw%3D%3D&crl=c>
7. Sailer I, Fehér A, Filser F, Lüthy H, Gauckler LJ, Schärer P, et al. Prospective clinical study of zirconia posterior fixed partial dentures: 3-year follow-up. *Quintessence Int*. 2006 Oct;37(9):685–93.
8. Kim JH, Lee S-J, Park JS, Ryu JJ. Fracture load of monolithic CAD/CAM lithium disilicate ceramic crowns and veneered zirconia crowns as a posterior implant restoration. *Implant Dent*. 2013 Feb;22(1):66–70.
9. Beuer F, Schweiger J, Eichberger M, Kappert H, Gernet W, Edelhoff D. High-strength CAD/CAM-fabricated veneering material sintered to zirconia copings — A new fabrication mode for all-ceramic restorations [Internet]. Vol. 25, *Dental Materials*. 2009. p. 121–8. Available from: <http://dx.doi.org/10.1016/j.dental.2008.04.019>
10. Duraisamy R, Krishnan CS, Ramasubramanian H, Sampathkumar J, Mariappan S, Sivaprakasam AN. Compatibility of Nonoriginal Abutments With Implants [Internet]. Vol. 28, *Implant Dentistry*. 2019. p. 289–95. Available from: <http://dx.doi.org/10.1097/id.0000000000000885>
11. Aboushelib M, Kleverlaan C, Feilzer A. Microtensile bond strength of different components of core veneered all-ceramic restorations Part II: Zirconia veneering ceramics [Internet]. Vol. 22, *Dental Materials*. 2006. p. 857–63. Available from: <http://dx.doi.org/10.1016/j.dental.2005.11.014>
12. Mazza LC, Lemos CAA, Pesqueira AA, Pellizzer EP. Survival and complications of monolithic ceramic for tooth-supported fixed dental prostheses: A systematic review and meta-analysis. *J Prosthet Dent* [Internet]. 2021 Mar 18; Available from: <http://dx.doi.org/10.1016/j.prosdent.2021.01.020>
13. Chen X-P, Xiang Z-X, Song X-F, Yin L. Machinability: Zirconia-reinforced lithium silicate glass ceramic versus lithium disilicate glass ceramic. *J MechBehav Biomed Mater*. 2020 Jan;101:103435.
14. Zhang Y, Lee JJ-W, Srikanth R, Lawn BR. Edge chipping and flexural resistance of monolithic ceramics. *Dent Mater*. 2013 Dec;29(12):1201–8.
15. Fischer J, Stawarczyk B, Tomic M, Strub JR, Hämmerle CHF. Effect of thermal misfit between

- different veneering ceramics and zirconia frameworks on in vitro fracture load of single crowns. *Dent Mater J*. 2007 Nov;26(6):766–72.
16. Sun T, Zhou S, Lai R, Liu R, Ma S, Zhou Z, et al. Load-bearing capacity and the recommended thickness of dental monolithic zirconia single crowns. *J MechBehav Biomed Mater*. 2014 Jul;35:93–101.
 17. Aparna J, Maiti S, Jessy P. Polyether ether ketone - As an alternative biomaterial for Metal Richmond crown-3-dimensional finite element analysis. *J Conserv Dent*. 2021 Nov;24(6):553–7.
 18. Ponnanna AA, Maiti S, Rai N, Jessy P. Three-dimensional-Printed Malo Bridge: Digital Fixed Prosthesis for the Partially Edentulous Maxilla. *ContempClin Dent*. 2021 Oct;12(4):451–3.
 19. Kasabwala H, Maiti S, Ashok V, Sashank K. Data on dental bite materials with stability and displacement under load. *Bioinformation*. 2020 Dec 31;16(12):1145–51.
 20. Agarwal S, Maiti S, Ashok V. Correlation of soft tissue biotype with pink aesthetic score in single full veneer crown. *Bioinformation*. 2020 Dec 31;16(12):1139–44.
 21. Merchant A, Maiti S, Ashok V, Ganapathy DM. Comparative analysis of different impression techniques in relation to single tooth impression. *Bioinformation*. 2020 Dec 31;16(12):1105–10.
 22. Agarwal S, Ashok V, Maiti S. Open- or Closed-Tray Impression Technique in Implant Prosthesis: A Dentist's Perspective. *J Long Term Eff Med Implants*. 2020;30(3):193–8.
 23. Rupawat D, Maiti S, Nallaswamy D, Sivaswamy V. Aesthetic Outcome of Implants in the Anterior Zone after Socket Preservation and Conventional Implant Placement: A Retrospective Study. *J Long Term Eff Med Implants*. 2020;30(4):233–9.
 24. Dinesh S, Kumaran P, Mohanamurugan S, Vijay R, Singaravelu DL, Vinod A, et al. Influence of wood dust fillers on the mechanical, thermal, water absorption and biodegradation characteristics of jute fiber epoxy composites. *J Polym Res*. 2019 Dec 6;27(1):9.
 25. Ponnulakshmi R, Shyamaladevi B, Vijayalakshmi P, Selvaraj J. In silico and in vivo analysis to identify the antidiabetic activity of beta sitosterol in adipose tissue of high fat diet and sucrose induced type-2 diabetic experimental rats. *ToxicolMech Methods*. 2019 May;29(4):276–90.
 26. Ezhilarasan D, Sokal E, Najimi M. Hepatic fibrosis: It is time to go with hepatic stellate cell-specific therapeutic targets. *HepatobiliaryPancreat Dis Int*. 2018 Jun;17(3):192–7.
 27. Vignesh R, Sharmin D, Rekha CV, Annamalai S, Baghkomeh PN. Management of Complicated Crown-Root Fracture by Extra-Oral Fragment Reattachment and Intentional Reimplantation with 2 Years Review. *ContempClin Dent*. 2019 Apr;10(2):397–401.
 28. Jeevanandan G, Govindaraju L. Clinical comparison of Kedo-S paediatric rotary files vs manual instrumentation for root canal preparation in primary molars: a double blinded randomised clinical trial [Internet]. Vol. 19, *European Archives of Paediatric Dentistry*. 2018. p. 273–8. Available from: <http://dx.doi.org/10.1007/s40368-018-0356-6>
 29. Rajeshkumar S, Menon S, Venkat Kumar S, TambuwalaMM, Bakshi HA, Mehta M, et al. Antibacterial and antioxidant potential of biosynthesized copper nanoparticles mediated through *Cissusarnotiana* plant extract. *J PhotochemPhotobiol B*. 2019 Aug;197:111531.
 30. Chen F, Tang Y, Sun Y, Veeraraghavan VP, Mohan SK, Cui C. 6-shogaol, a active constituents of ginger prevents UVB radiation mediated inflammation and oxidative stress through modulating NrF2 signaling in human epidermal keratinocytes (HaCaT cells). *J PhotochemPhotobiol B*. 2019 Aug;197:111518.
 31. Murugan MA, Arul Murugan M, Jayaseelan V, Jayabalakrishnan D, Maridurai T, Selva Kumar S, et al. Low Velocity Impact and Mechanical Behaviour of Shot Blasted SiC Wire-Mesh and Silane-Treated Aloe vera/Hemp/Flax-Reinforced SiC Whisker Modified Epoxy Resin Composites [Internet]. Vol. 12, *Silicon*. 2020. p. 1847–56. Available from: <http://dx.doi.org/10.1007/s12633->

019-00297-0

32. Nandhini NT, Rajeshkumar S, Mythili S. The possible mechanism of eco-friendly synthesized nanoparticles on hazardous dyes degradation. *BiocatalAgricBiotechnol*. 2019 May 1;19:101138.
33. Ezhilarasan D. Oxidative stress is bane in chronic liver diseases: Clinical and experimental perspective. *Arab J Gastroenterol*. 2018 Jun;19(2):56–64.
34. Rajagopal R, Padmanabhan S, Gnanamani J. A comparison of shear bond strength and debonding characteristics of conventional, moisture-insensitive, and self-etching primers in vitro. *Angle Orthod*. 2004 Apr;74(2):264–8.
35. Muthukrishnan S, Krishnaswamy H, Thanikodi S, Sundaresan D, Venkatraman V. Support vector machine for modelling and simulation of Heat exchangers. *Thermal Science*. 2020;24(1 Part B):499–503.
36. Wu F, Zhu J, Li G, Wang J, Veeraraghavan VP, Mohan SK, et al. Biologically synthesized green gold nanoparticles from *Siberian ginseng* induce growth-inhibitory effect on melanoma cells (B16) [Internet]. Vol. 47, *Artificial Cells, Nanomedicine, and Biotechnology*. 2019. p. 3297–305. Available from: <http://dx.doi.org/10.1080/21691401.2019.1647224>
37. Neelakantan P, Sharma S, Shemesh H, Wesselink PR. Influence of Irrigation Sequence on the Adhesion of Root Canal Sealers to Dentin: A Fourier Transform Infrared Spectroscopy and Push-out Bond Strength Analysis. *J Endod*. 2015 Jul;41(7):1108–11.
38. Sahu D, Kannan GM, Vijayaraghavan R. Carbon black particle exhibits size dependent toxicity in human monocytes. *Int J Inflam*. 2014 Feb 5;2014:827019.
39. Crisp RJ, Cowan AJ, Lamb J, Thompson O, Tulloch N, Burke FJT. A clinical evaluation of all-ceramic bridges placed in UK general dental practices: first-year results. *Br Dent J*. 2008 Nov 8;205(9):477–82.
40. Ashok V, Nallaswamy D, Benazir Begum S, Nesappan T. Lip Bumper Prosthesis for an Acromegaly Patient: A Clinical Report. *J Indian Prosthodont Soc*. 2014 Dec;14(Suppl 1):279–82.
41. Al-Atyaa ZT, Majeed MA. Comparative Evaluation of the Marginal and Internal Fitness of Monolithic CAD/CAM Zirconia Crowns Fabricated from Different Conventional Impression Techniques and Digital Impression Using Silicone Replica Technique (An in vitro study) [Internet]. Vol. 11, *Biomedical and Pharmacology Journal*. 2018. p. 477–90. Available from: <http://dx.doi.org/10.13005/bpj/1397>
42. Hamza TA, Sherif RM. Fracture Resistance of Monolithic Glass-Ceramics Versus Bilayered Zirconia-Based Restorations. *J Prosthodont*. 2019 Jan;28(1):e259–64.
43. Lopez-Suarez C, Rodriguez V, Pelaez J, Agustin-Panadero R, Suarez MJ. Comparative fracture behavior of monolithic and veneered zirconia posterior fixed dental prostheses. *Dent Mater J*. 2017 Nov 29;36(6):816–21.
44. Solá-Ruiz MF, Lagos-Flores E, Román-Rodríguez JL, Highsmith JDR, Fons-Font A, Granell-Ruiz M. Survival rates of a lithium disilicate-based core ceramic for three-unit esthetic fixed partial dentures: a 10-year prospective study. *Int J Prosthodont*. 2013 Mar;26(2):175–80.
45. Pihlaja J, Näpänkangas R, Raustia A. Outcome of zirconia partial fixed dental prostheses made by predoctoral dental students: A clinical retrospective study after 3 to 7 years of clinical service. *J Prosthet Dent*. 2016 Jul;116(1):40–6.
46. Freire Y, Gonzalo E, Lopez-Suarez C, Suarez MJ. The Marginal Fit of CAD/CAM Monolithic Ceramic and Metal-Ceramic Crowns. *J Prosthodont*. 2019 Mar;28(3):299–304.
47. Håff A, Löf H, Gunne J, Sjögren G. A retrospective evaluation of zirconia-fixed partial dentures in general practices: an up to 13-year study. *Dent Mater*. 2015 Feb;31(2):162–70.
48. Ajay R, Suma K, Ali SA, Kumar Sivakumar JS, Rakshagan V, Devaki V, et al. Effect of Surface

- Modifications on the Retention of Cement-retained Implant Crowns under Fatigue Loads: An In vitro Study. *J Pharm Bioallied Sci.* 2017 Nov;9(Suppl 1):S154–60.
49. Agarwal S, Ashok V, Maiti S. PREVALENCE OF DIFFERENT FULL VENEER CROWNS IN A UNIVERSITY HOSPITAL SETTING. *European Journal of Molecular & Clinical Medicine.* 2020;7(1):2097–106.
 50. Habib SR, Ali M, Al Hossan A, Majeed-Saidan A, Al Qahtani M. Effect of cementation, cement type and vent holes on fit of zirconia copings. *Saudi Dent J.* 2019 Jan;31(1):45–51.