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Prevalence Of Ceramic Failure Among Fixed Dental Prosthesis

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Abstract

Fixed Partial Prostheses (Fpds) Have Been Successfully Used For More Than Four Decades. These Prostheses Are Considered A Reliable And Long Lasting Device In Oral Service, Porcelain Fracture Associated With An Implant-Supported, Metal Ceramic Crown Or Fixed Partial Denture Occurs At A Higher Rate Than In Tooth-Supported Restorations, According To The Literature. Clinical Data On Survival Rates Reveal That All-Ceramic Dental Prostheses Are Susceptible To Fracture From Repetitive Occlusal Loading.The Aim Of The Study Is To Evaluate The Prevalence Of Ceramic Failure Among Fixed Dental Prosthesis.A Cross Sectional Study Was Conducted From June 2019 To March 2020. Patient Records Were Collected And Evaluated. Patients Having Ceramic Failure With Respect To Their Fixed Dental Prostheses Were Selected For The Study. The Most Common Cause Of Ceramic Failure In Fixed Partial Denture Was Found To Be Fracture Of Ceramic Veneer In Prosthesis. (79.4%) Followed By Unaesthetic Prosthesis (9.5%) Discolouration Of Prosthesis (7.9%), And Worn Out Prosthesis (3.2%). The Prevalence Of Ceramic Failure Was Present More In Females As Compared To Males Within The Limits Of The Present Study, It Can Be Concluded That The Most Common Type Of Ceramic Failure Is Fracture Of Ceramic Veneer Which Is More Prevalent In Females Rather Than Males

Key Words: Broken Prosthesis; Ceramic; Chipped Prosthesis; Fixed Dental Prosthesis; Missing Tooth

1.Introduction

Major Dental Restorations Such As Crowns And Fixed-Partial Dentures (Fdps), As Well As Other Biomechanical Prostheses, Are Experiencing A Rapid Shift Towards Ceramic Materials, Partially For Their Strength And Bio Inertness But More So For Their Aesthetics[1.] However, Ceramics Are Brittle And Susceptible To Fatigue Fracture In

Repetitive Function [2]. Although Occlusal Loading Is Nominally Compressive, [3] With Bite Forces Supported In Individual 'Dome-Like' Structures (Crowns) Or In Frameworks With Connectors (Fdps), Some Tensile Stresses Are Inevitable.[4] Cracks Tend To Follow Paths Where These Tensile Stresses Are Greatest. [5]while A Ceramic Restoration May Fracture Abruptly From A Single Intense Overload,[6] It Is More Likely That Failure Will Occur Cumulatively After An Extended Period Of Seemingly Innocuous But Lower-Load Biting Events. Such Fractures Are Manifest In The Clinical Literature As 'Lifetime' Or 'Survival Rate' Data. [7,8]

The Drive Towards Ceramic Restorations Is Fraught With Compromise [9]. There Is A Perception That Ceramic Crowns And Fdps Are Not Yet As Reliable As Those With Traditional Metal Frameworks.[10] The Ceramics With The Most Desirable Aesthetics, Notably Porcelains, Tend Also To Have The Lowest Resistance To Crack Propagation [11]. Conversely, Tougher Ceramics Such As Aluminas And Zirconias [12] Are Not Generally Aesthetic. Glass–Ceramics [13] Occupy A Middle Ground. Given The Brittleness Of Ceramics, It Is Hardly Surprising That Prosthetic Failures Do Occur. They Include Cracks Initiating From The Contact Zone At The Occlusal Surface,[14] From The Cementation Surface Beneath The Contact,[15] And From The Margins Of Crowns And Connectors In Fdps. [16]

All Of These Cracks Can Result In Severe Damage Or Irrecoverable Failure. [17] Chipping Fractures Initiate From Contact Damage Sites And Detach At Least Part Of The Veneer From The Core. Through-Thickness Fractures Initiate From The Occlusal Or Cementation Surface Beneath The Contact Or From The Margins Or Connectors And Can Split A Prosthesis In Two.[18] Clinical Trials Reporting Survival Rates For Several All-Ceramic Systems Indicate Vulnerabilities To All These Fractures. [19] Broadly Speaking, Porcelain Veneered Systems Show Higher Fracture Rates Than Fullcontour Monoliths, Fdps More Than Single Crowns, And Glass–Ceramic More Than Zirconia Monoliths, Although The Variability In Data From Study To Study Can Be High.[18]

The Physical Mechanisms Of Fatigue In Ceramic Restorative Materials Have Not Been Well Documented In The Dental Literature. [20]the Prevailing View, Borrowed Originally From Fundamental Studies In The Materials Science Community, Is That Fatigue Can Be Accounted For By Chemically Enhanced, Rate-Dependent Crack Growth In The Presence Of Moisture. [21] According To This Viewpoint, Water Enters Incipient Fissures And Breaks Down Cohesive Bonds Holding The Crack Walls Together.[22] The Result Is So-Called 'Subcritical' Or 'Slow' Crack Growth (Scg) Which Progresses Steadily Over Time, Accelerating At Higher Stress Levels And Ultimately Leading To Failure.[23] The Notion Is Attractive Because It Lends Itself To Rigorous 'Fracture Mechanics' Analysis In Terms Of Explicit Crack Velocity Equations[24] , Enabling One To Predict Lifetimes In Terms Of Specified Stress States.[25] But Recent Studies[26] In The Materials Science Arena Reveal That Fatigue Is More Complex Than Just Scg. In Addition To Chemical Degradation, There Are Mechanisms Of Mechanical Degradation That Can Augment The Fatigue Process.[27] Flaw Distribution And Damage Mechanisms In Ceramic Fpds Are Difficult To Analyze Because Of The Complex Geometry, Fluctuating Stresses And Contact Damage In The Oral Environment.[28] Previously Our Team Has A Rich Experience In Working On Various Research Projects Across Multiple Disciplines The [29–3132–43].The Aim Of The Study Is To Evaluate The Prevalence Of Ceramic Failure Among Fixed Dental Prosthesis

2.Materials And Methods

The Present Cross Sectional Study Was Carried Out In The Department Of Prosthodontics Of Saveetha Dental College And Hospital, Chennai, Tamil Nadu. The Study Was Of University Setting And Carried Out Using Data Collected From Patient Management Software From June 2019-March 2020. The Advantage Of Using A University Setting Is That Data Is Readily Available And Patients Are Of Similar Ethnicity. The Disadvantage Of This Type Of Setting Is That It Covers A Specific Geographic Area And Trends In Other Locations Are Not Assessed. Ethical Approval Was Obtained From The Institution. The Data Was Reviewed By 2 Reviewers. Case Verification Was Done By 2 Reviewers. Non Probability Sampling Of The Available Data Was Done. The Sample Size Consisted Of 63 Patients Who Had Undergone Fixed Dental Prosthesis Therapy And Experienced Ceramic Failure. Inclusion Criteria Included All The Patients Who Had Undergone Fixed Dental Prosthesis Therapy And Experienced Some Sort Of Ceramic Failure. Failure Included Ceramic Fracture Of Veneer In Prostheses, Ill Contoured And Unesthetic Prostheses,Colour Mismatch And Wearing Down Of Ceramic.

Data Collection Was Carried Out Using Dental Archives Obtained From The Patient Management Software. Data Verification Was Carried Out. The Data Was Tabulated Using Microsoft Excel. Censored Or Incomplete Data Was Excluded From The Study.The Data Was Imported To Spss Software (2020 Version) Developed By Ibm And Statistical Tests Were Carried Out.

3.Results And Discussion

In Our Study, The Most Common Cause Of Ceramic Failure In Fixed Partial Denture Was Found To Be Fracture Of The Ceramic Veneer In Prosthesis (79.4%) Followed By Ill Contoured And Unaesthetic Prosthesis (9.5%) Colour Mismatch And Discolouration Of Prosthesis (7.9%), And Worn Out Prosthesis (3.2%). (Figure 1) Females Appeared To Sustain More Ceramic Failure Than Males, However The Association Between Gender And Ceramic Failure Is Not Significant. (Pearson Chi Square Test; P=0.754,P >0.05) (Figure 2)

In A Study Conducted By Kelly Et Al [44], The Results Revealed That Failures Were Seen To Originate From Either The External Surface Of The Connector (Free Surface Origin) Or From The Core-Veneer Interface Within The Gingival Portion Of The Connector (Interface Origin).

Study By Bulpakdi Et Al [45] Indicates That The Possible Reasons Of Clinical Failure Is Not Poor Processing Of The Veneer, But Rather Could Be Occlusal Over-Loading, Fatigue, Stress Corrosion Or Improper Fpd Design. Even Though The Fracture Strength Of The All-Ceramic Fpds Was Greater Than Peak Physiological Chewing Forces, Long-Term Repetitive Low Level Loading May Cause Ceramic Fpds To Fracture At Stress Levels Much Less Than The Strength Of The Material[46]. The Intraoral Failure Can Occur Due To The Oral Environment And Is Related To Fatigue Failure Of Dental Ceramic Restorations. The Strength Degradation (Fatigue) Of Dental Ceramics In Corrosive Environments Is A Result Of Subcritical Crack Growth [47]. Failure Generally Occurs After Long Loading Times And At Stresses Less Than The Measured Short-Term Fracture Strength. The Degree Of Crack Growth Is Dependent On Both The Magnitude And The Duration Of The Applied Stress [48]. Improper Design Of Fpds Is Also One Of The Potential Failure Reasons. Fracture Of Fpds Tends To Occur In The Connector Area Because Of Stress Concentrations. A Compressive Stress Is Distributed Within Fpds At The Occlusal Embrasure And A Tensile Stress Is Distributed At The Gingival Embrasure. Stresses Are Better Distributed With Broadly Curved Connectors Than Through The Use Of Sharply Curved Connector. Thus, Failure Rate Increases When The Connector Is Sharper [48,49].Our Institution Is Passionate About High Quality Evidence Based Research And Has Excelled In Various Fields ([50–60].

A Study By Zhang Et Al[48,49,61] Implies Ceramics Are Susceptible To Loss Of Load-Bearing Capacity In Cyclic Loading, I.E. Fatigue, Amounting To Declines In Strength Or Critical Bite Force Amounting To A Factor Of 2 Or More Over An Equivalent One-Year Biting History. (Part Of Fatigue Is Due To Well-Documented Chemically Assisted Slow Crack Growth (Scg), But More Deleterious Is Degradation By Mechanical Processes Such As Hydraulic Pumping And Internal Friction At Microcrack Walls.

4.Conclusion

Fracture Of The Ceramic Veneer Is The Most Common Type Of Ceramic Failure Observed In This Study.Ceramic Failure Is Seen To Be More Prevalent In Females Rather Than Males. Hence Additional Impetus Should Be Given In Both Clinical And Laboratory Procedures To Minimize Determinants Contributory To Ceramic Failure,Thus Ensuring Enhanced Clinical Performance.

5.Acknowledgement

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6.Conflict Of Interest

There Is No Conflict Of Interest Present.

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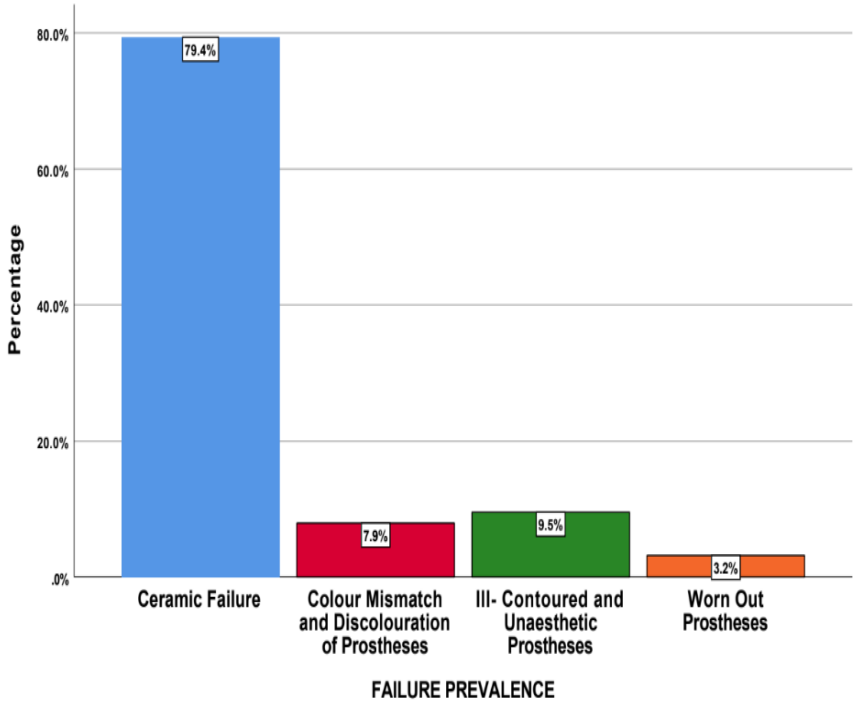

Figure 1: This Bar Graph Represents The Reasons For Ceramic Failure Among Patients Who Have Undergone Fixed Prostheses Therapy. X Axis Represents The Reason For Failure Prevalence And Y Axis Represents The Percentage Of Participants In The Study. The Most Common Reason Was Ceramic Fracture (79.4%) Followed By Unaesthetic Prostheses (9.5%), Discolouration Of Prostheses (7.9%) And Worn Out Prostheses (3.2%).

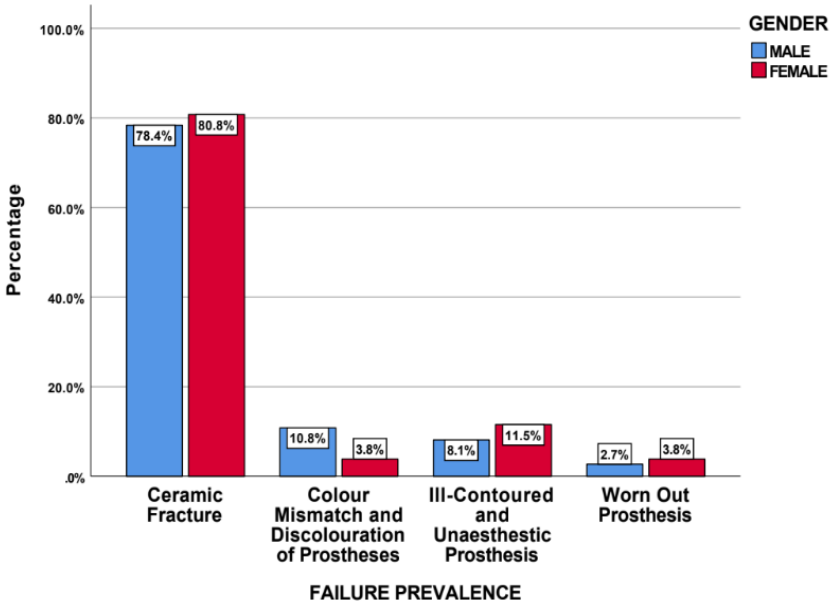

Figure 2: Association Between Gender And Ceramic Failure. X Axis Represents The Failure Prevalence And Y Axis Represents The Percentage Of Participants In The Study Where Males (Blue) Females (Red), (Pearson Chi Square Test; P=0.754,P >0.05) Statistically Not Significant Though Females Appeared To Sustain More Ceramic Failure Than The Males.