Understanding Problems and Failures in TSFDP

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Understanding Problems and Failures in TSFDP

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Abstract

Fixed prosthodontic treatment in the form of teeth supported fixed dental prosthesis (TSFDP) is hugely a popular treatment in many countries. The treatment usually helps in restoration of missing natural tooth or teeth by way of crown preparation of potential existing natural teeth called abutments which shall be covered by retainers and the pontic shall replace the missing dentition. Numerous biological, mechanical, technical and esthetic factors should always be considered before concluding on the treatment plan. Proper treatment planning shall consist of selection of abutment teeth, their periodontal status, number of abutments, angulation, relative parallelism, mode of preparation of abutments, selection of pontic, design, nature of residual ridge, choice of restorative material, shade selection, choice of luting agent. Unless due attention is given to the factors mentioned above, the failure in a fixed prosthesis is always a possibility. This article describes the various failure modes of FDP (fixed dental prosthesis) in an orderly manner and possible reasons for the same.

Discussion

FIXED DENTAL PROSTHESIS
Important signs and symptoms which points out development of problems or failures in a fixed dental prosthesis which had been given recently to the patient or which had been given several months or years had been pointed out below

SIGNS AND SYMPTOMS OF FAILURES IN FDP
Looseness of the FDP
Rocking on chewing & during function
Continued Ingress of food and saliva
Caries under the FDP
Increased Gingival inflammation under the pontic/retainer
Progressive Gingival recession
Periapical inflammation of abutment
Food impaction
Tooth mobility
Fracture or loss of facing
Discoloration
Perforation of metal frame
Pain on percussion or Sensitivity of abutment
Outright fracture of FDP
Supra eruption/mesial drifting of adjacent teeth

Charles etal1 Described the Incidence of Failures in His Article
Single Crown Complications Duration-1 to 23 years.

(studies) Incidence of complications 11%
FDP complications Duration-1 to 20 years. (studies)
Incidence of complications 27%
All Ceramic Complications Duration-1 month to 14 years. (studies)
Incidence of complications 8%
Resin Bonded prosthesis Complications Duration-1 month to 15 years. (studies)
Incidence of complications 26%

CLASSIFICATION - Bennard G. N. Smith
Loss of retention
Mechanical failure of crowns or bridge components
Porcelain fracture
Failure of solder joints
Distortion
Occlusal wear and perforation
Lost facings
Changes in the abutment tooth
Periodontal disease
Problems with the pulp
Caries
Fracture of the prepared natural crown or root
Movement of the tooth
Design failures
Under-prescribed FPDs
Over-prescribed FPDs

Inadequate clinical or laboratory technique
a. Positive ledge
b. Negative ledge
c. Defect
d. Poor shape and color

Occlusal problems
Oginni2 described the failures of FPD fabricated in a Nigerian dental school. John J Manapallil3 described a classification system for conventional crown and fixed partial dentures failures. He described it based on the increasing severity from class 1 to class 6.
Grading of failures based on severity

Class I - Cause of failure is correctable without replacing restoration
Class II - Cause of failure is correctable without replacing restoration; however, supporting tooth structure or foundation requires repair or reconstruction
Class III - Failure requiring restoration replacement only. Supporting tooth structure and/or foundation acceptable.
Class IV - Failure requiring restoration replacement in addition to repair or reconstruction of supporting tooth structure and/or foundation
Class V - Severe failure with loss of supporting tooth or inability to reconstruct using original tooth support. Fixed prosthodontic replacement remains possible through use of other or additional support for redesigned restoration.
Class VI - Severe failure with loss of supporting tooth or inability to reconstruct using original tooth support. Conventional fixed prosthodontic replacement is not possible.

Selby4 reviewed the important aspects of fixed

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prosthodontic failure. For ease of understanding problems and failures of FDP, in this article the following description had been given.

TYPES OF FAILURES IN FDP
Cementation failure
Mechanical failure
Gingival and periodontal breakdown
Caries
Pulp degeneration
Biomechanical failure
Esthetic failure

1. CEMENTATION FAILURES
CEMENTATION FAILURE Can be broadly divided into:
Cement failure
Retention failure
Occlusal problems
Distortion of FDP

Cement failure
Causes of cement failure

Cement selection
Old cement
Prolonged mixing time
Thin mix
Cement setting prior to seating
Inadequate isolation
Incomplete removal of temporary cement
Thick cement space
Inclusion of cotton fibers
Insufficient finger pressure causing incomplete seatings

Complications due to incomplete seatings

Creation of premature contacts
Alteration of contact areas with adjacent teeth
Reduction in crown retention by 19-32%
Discrepancies in the marginal fit of the crown
Cement wash out at the margins - expose large amounts of cements to oral fluids - increasing rate of deposition of plaque.

Methods to improve marginal fit:
Venting
Internal relief (clinically acceptable – 20-40µm)
Selection of luting agent

The primary function of the luting agent is to provide a seal preventing marginal leakage and pulp irritation.
The luting agent should not be used to provide significant retentive and resistive forces.
An ideal luting agent should have the following properties:

Adequate working time
Adhere well to both tooth structure and metal surface
Provides a good seal
Non toxic to the pulp
Have adequate strength properties
Be compressible into thin layers
Have low viscosity and solubility
Exhibit good working time and setting properties

B. Retention failure
For a restoration to accomplish its purpose, it must stay in place on the tooth. The geometric configuration of the tooth preparation must place the cement in compression to provide the necessary retention and resistance.

Causes for Retention Failure
Excessive taper
Short clinical crowns
Mis-fit
Misalignment

Excessive taper:
The axial walls of the preparation must taper slightly to permit the restoration to get seated.
Recommendations for optimal axial wall taper of tooth preparations for cast restorations ranged from 10 to 12 degrees.

Short clinical crown:
Cement creates a weak bond largely by mechanical interlocks between the inner surface of the restoration and the axial wall of the preparation. Therefore, the greater the surface area of the preparation the greater is its retention.
The length must be great enough to interfere with the arc of the casting pivoting about a point on the margin on the opposite side of the restoration. The walls of short preparations should have as little taper as possible. Clinical conditions with excessive taper and short clinical crowns should be treated with:

1. In case of excessive taper:
   Incorporation of proximal grooves.
   Additional retentive grooves
   Additional pins
   2. In case of short crowns:
      Crown lengthening procedure
      Modification of supra-gingival margin to sub-gingival margin
      Additional retentive grooves and proximal box
      Incorporation of pins
      Addition of extra abutments

Misfit:
The measurement of misfit at different locations and geometrically related to each other and defined as:

Internal gap
Marginal gap
Vertical marginal discrepancy
Horizontal marginal discrepancy
Over-extended margin
Under-extended margin

A. Causes for misfit
Defective casting
Porcelain flowed inside the retainer
Excessive oxide layer formation in inner side of the retainer (due to contaminated metal or repeated firing of porcelain)
Tight contact points with abutment teeth
Incorrect manipulation of luting agents
Insufficient pressure during cementation procedure

B. Misalignment

It is more difficult to differentiate whether a FDP is not seating because of a faulty fit, or the alignment of the retainers relative to each other is incorrect. The only difference which may sometimes be apparent is that, in the case of misalignment the FDP will have some ‘spring’ action in it and tend to seat further on pressure due to the abutment teeth moving slightly, whereas in the case of a defective fit, the resistance felt will be solid.

Causes for misalignment

Abutment displacement due to improper temporization.
Distortion of wax pattern while sprueing and investing.
Casting defects
Distortion of metal frameworks in porcelain firing.
Porcelain flow inside the retainers.
Insufficient pressure in cementation.

Causes of distortion

Casting defects-
Distorted margin,
Rough castings,
Bending of the FDP due to improper care taken during wax pattern making,
Investing and casting procedures.
Bending of long span FPDs due to Thin crown, Soft metal, Heat treatment not being done, Porosity in the metal.
Distortion of the metal substructure during the porcelain firing.

2. MECHANICAL FAILURES

1. Retainer failure
2. Pontic failure
3. Connector failure

RETAINER FAILURE
Perforation
Marginal discrepancy
Facing failure
Fracture

Wen Kou et al5 conducted a study to examine the fracture mechanism and process of ceramic fixed partial denture (FPD) framework under simulated mechanical loading using a recently developed numerical modeling code, the R-T2D code, and also to evaluate the suitability of R-T2D code as a tool for this purpose. Based on the findings in the study, the R-T2D code seems suitable for use as a complement to other tests and clinical observations in studying stress distribution, fracture mechanism and fracture processes in ceramic FPD frameworks.

Wearing
Discoloration

A. Perforation

Causes

Insufficient occlusal reduction
Insufficient occlusal material
High points in opposing dentition (plunger cusp)
Premature contacts
Contaminated metal
Porosity in metal work (subsurface, back pressure, suck back)
Due to improper melting temperature
Improper pattern position
Improper sprue (too thin)
Improper location
Parafuctional habits

Burak et al6 conducted a study to evaluate the clinical performance of crowns and fixed partial dentures (FPDs) made with the Empress 2 system over a 2-year period. U.S. Public Health Service criteria showed 100% Alpha scores concerning recurrent caries for both crowns and FPDs. No crown fractures were observed during the 2-year followup, however, 10 (50%) catastrophic failures of FPDs occurred. Five (25%) failures occurred within the 1-year clinical period and the others (25%) within the second year.

B. Marginal discrepancy

Causes

Selection of finish margin
Improper preparation and failure to establish the margin properly
Failure to do gingival retraction prevents definite margin location and subsequently in impression
Selection of the impression material
i. Shrinkage in material (condensation silicone)
ii. Distortion of material (alginate)

Improper impression procedures
Voids in the impression
Variation in pressure application in wash technique
Delayed pouring of die material
Distortion of wax patterns at margins
Impressions

FINAL IMPRESSION PROCEDURES
I) Selection of tray – correct size
Under extended – insufficient coverage
Over extended – distortion
II) Moisture control – successful impression making
III) Adequate tissue retraction
IV) Do not remove the impression before it sets
V) Voids, incomplete details are the usual errors made with hasty handling of the impression material
VI) An acceptable impression must include sufficient unprepared tooth immediately adjacent to the margins for the dentist and lab technician to identify the contour of the tooth and all the prepared tooth surfaces
VII) Particular attention to the lingual contour of the anterior as they influence the anterior guidance
VIII) Impression defects- visible flaws
IX) Finish line not visible
Gingival inflammation and bleeding
Subgingival finish line
Localized Gingival overgrowth
Retraction cord displaced
X) Air bubbles in critical places
XI) Voids and drags
XII) Unset impression material – latex contamination
XIII) Impression defects- Invisible flaws, restoration fit on the die , but not on the mouth
XIV) Tray and impression recoil Detachment of impression from the tray
XV) Permanent deformation
K) Insufficient flow of metal
L) Shrinkage of metal
M) Nodules in margins and inner side of coping
i. Due to inadequate vacuum during investing
ii. Improper brushing technique
iii. No surfactant
N) Excessive sand blasting
O) Distortion due to degassing procedure
P) Open margins due to porcelain shrinkage (opaque porcelain)
Q) Thick mixing of luting agent
R) Cement setting prior to seating
S) Insufficient pressure application during cementation
C. Facing failure
Types of veneer failures
a) Fracture
Panida et al7 conducted a study to test the hypothesis that fracture toughness of the veneers in clinically failed zirconia-based fixed partial dentures (FPDs) is not significantly different from that of the in vitro group and to determine the potential reasons for their failures. The study showed that Fractal analysis is shown to be an alternative analytic tool for clinically failed ceramic restorations, especially for those with fracture origins chipped off during mastication and hence could not be analyzed using other techniques, such as fractography.

b) Wearing of facing (resin veneers)
c) Discoloration

PONTIC FAILURE
Pontic is the articial tooth which replaces the natural missing tooth or teeth

Factors affecting selection and failure of pontics
1) Pontic space
2) Residual ridge contour
3) Biological consideration
   a. Ridge relation
   b. Dental plaque
   c. Gingival surface of pontic
      (Contact with mucosa)
      i. Mucosal contact
      ii. Non mucosal contact
4) Pontic ridge relationship
5) Pontic material
6) Biocompatibility
7) Occlusal forces
8) Metal substructure support

What factors should be considered when choosing a pontic?
Tissue contact
Post insertion hygiene
Pontic design
Ridge lap pontic
Modified ridge lap pontic
Sanitary pontics

3. CONNECTOR FAILURE
The connector is that part of the FPD or splint that joins the individual components (retainers and pontics) together.

Causes for connector failure
Improper selection of connector
Thin metal at the connector
Incorrect selection of solder
Solder gap – narrow or wide
Porosity
Insufficient metal around
Defective occlusal contacts over thin connectors
Garry et al8 conducted a study to assess the effect of core to dentine thickness ratio on the bi-axial flexure strength and fracture mode and failure origin using bilayered ceramic specimens as an in vitro assessment for all-ceramic crowns and the connector area of fixed partial dentures (FPDs). The fracture mode and failure origin in bilayered ceramics tested to represent the failure mode of all-ceramic crowns and FPDs was dependent upon the core to dentine thickness ratio employed. However, the conventional wisdom regarding bilayered ceramic specimens with core thicknesses greater than 1 mm are not followed when the core thickness was reduced to 1 mm since the fracture resistance was not dependent on the core
to dentine thickness ratio.

3. GINGIVAL AND PERIODONTAL PROBLEMS

FINISH MARGIN

Margins are one of the most important and weakest links in the success of FPD restorations. One of the prime goals of restorative therapy is to establish a physiologic periodontal health.

A successful prosthesis depends on a healthy periodontal environment and periodontal health depends on the continued integrity of the prosthodontic restoration.

The margin is one of the components of the cast restoration most susceptible to failure, both biologically and mechanically. Most of the investigative proof shows that supragingival margins are kinder to the gingiva than are subgingival margins. However, practicality dictates that supragingival margins are not always usable.

Failure to reproduce the margin of the preparation in the impression leads to failure in the marginal integrity of the restoration. Using of gingival retraction technique in case of subgingival preparation is mandatory. However, all displacement techniques have the potential to damage gingiva, attachment apparatus and bone, especially if anatomic forms are weak or if disease is present.

In healthy patients, properly used cord displacement or copper band methods have proved to be atraumatic.

CONTOUR

Overcontoured restoration - plaque accumulation and gingival inflammation

Buccally and lingually crown should follow the outline of the tooth

Interproximally - slightly concave to permit optimal plaque control without compromising aesthetics

INTERPROXIMAL EMBRASURES

Must allow access for plaque control

Axial reduction must allow for thickness of restorative material and oral hygiene

May have to compromise in anterior region due to black triangles leading to poor aesthetics

CONTACT POINTS

Contact points are required to prevent food packing. Position varies depending which tooth contact is made;

- upper central incisors - incisal third
- upper central and lateral incisors - middle third
- upper laterals and canines - gingival third

PREVENTION OF PERIODONTIUM

When the margin of the restoration intrudes into the biologic width, the inflammation and osteoclastic activity are stimulated. Bone resorption will continue until the alveolar crest is at least 2mm from the restoration margin.

4. CARIES CAUSES

iatrogenic (dentists’ role)

Failure to identify caries in abutments

Incomplete removal of caries in abutments

Marginal discrepancy with subsequent plaque accumulation and microleakage

Subgingival marginal placement in inaccessible areas or regions

Burning of root dentin or cementum in electro surgical technique (leads to damage or rough surface and causes plaque retention)

Over contouring of the cervical thirds of crowns or bridges prevents the physiologic tooth cleaning by tongue or muscles

Thick cement space in margins leads to cement dissolution.

Narrow embrasures (inaccessibility to maintain hygiene)

Wide connector

Patient role

Systemic factors

Xerostomia

Due to radiation therapy

Drug induced

Endocrine disorders

Epilepsy (difficult to maintain the oral hygiene)

Rheumatoid arthritis

Local factors

Improper brushing and flossing

Dietary habits

Failure to understand importance of oral hygiene.

5. PULP DEGENERATION

Pulp reactions to various procedures should always be considered

Each step in full crown preparation is hazardous, to the pulp. In general, heat desiccation or chemical injury or over preparation with less than 1mm of reaming dentin.

The result may be pulpitis or even necrosis.

Preservation of tooth structure

Devan – “preservation of what remains is most important than the restoration what is lost” Use of partial coverage rather than the complete coverage Preparation of teeth with minimum convergence angle (taper) between the axial walls of Preparation.

Anatomic reduction of the occlusal surface, so reduction follows the anatomic planes to give uniform thickness in the restoration.

6. BIOMECHANICAL FAILURES

Causes:

Failure in selection of right abutment

Lack of retention and resistance form

Incorrect design of FPD

Wrong material selection

Such failures can be avoided in the following ways

Retention and Resistance Form given in abutment helps in

Degree of Taper - parallelism

Minimise shear forces - grooves, boxes

Large surface area of cement

Preparation length and width

Path of insertion
Structural Durability achieved by Adequate Anatomic Occlusal Reduction
Functional Cusp Bevel - Given on the functional cusps
Lingual inclines of the maxillary lingual cusp
Buccal inclines of the mandibular buccal cusp

7. ESTHETIC FAILURES
REASONS FOR ESTHETIC FAILURE
Failure to identify patient expectations regarding esthetics
Improper shade selection
Excessive metal thickness at incisal and cervical regions
Thick opaque layer application
Over glazing or too smooth a surface
Metal exposure in connector, cervical and incisal regions (antennas)

Kugel et al9 also described restoration of edentulous anterior maxilla using alumina and zirconia based CAD CAM restorations.

Failure to produce incisal and proximal translucency
Improper contouring
Failure to harmonize contra lateral tooth morphology
Contour
Color
Position
Angulation

Dark space in cervical third due to improper pontic selection
Discoloration of facing

Esthetical Considerations in Tooth Preparation
Facially inclined tooth – overcutting of the mesiobuccalocclusal corner – display of metal
Lingually inclined tooth – facial surface intersects lingual-shorter preparation, may encroach on pulp
Under preparation results in poor aesthetics or an over built crown (dotted line) with periodontal and occlusal consequences.
Conversely over preparation can be compensated by making a thicker and perhaps very aesthetic crown, but the strength and pulpal vitality of the underlying tooth may be compromised.
In reality, preparations should be planned according to each individual case and in each case the existing situation will be different.

Goodacre et al10 conducted a MEDLINE search, 50-year literature review of survival and failure modalities of FPD. Fixed partial dentures failures: caries (18% of abutments and 8% of prostheses), endodontic treatment (11% of abutments and 8% of prostheses), loss of retention (7% of prostheses), esthetics (6% of prostheses), periodontal disease (4% of prostheses), tooth fracture (3% of prostheses), and prosthesis/porcelain fracture (2% of prostheses). Lindquist et al11 also conducted a study on success and failure rates of FPD after 20 years in service.

Conclusion(s)
It is imperative to understand that a successful fixed prosthodontic practice requires Knowledge of sound biological and mechanical principles involved in abutment selection and subsequent preparation techniques. Growth of desirable and acceptable manipulative skills to implement the treatment plan identified for the particular patient. Development of a critical eye and judgment for assessing details of the treatment and subsequent prognosis.

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