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Failure Concepts In Prosthodontics

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The College of Dentistry, University of Baghdad, Department of prosthodontic in Partial Fulfillment for the degree of Bachelor of Dental Surgery

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Certification of the Supervisor

I certify that this project entitled "**Failure Concepts in Prosthodontics**" was prepared by the fifth-year student **Mujtaba Salih Abd Al-ameer** under my supervision at the College of Dentistry/University of Baghdad in partial fulfilment of the graduation requirements for the Bachelor Degree in Dentistry.

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Dedication

I dedicate this project to the warmest embrace, the greatest bond and the owner of the greatest merit to our country and our origins to (Iraq).

To those who have reached this stage thanks to them, their fatigue, their constant struggle, and their constant support, to our parents and family, our teachers.

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And I would like to thank my best friend, for his support and encouragement.

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Abbreviations	Word
RPD	Removal Partial Denture
FPD	Fixed Partial Denture
CBCT	Cone Beam Computed Tomography
CAD	Computer-Aided Design
CAM	Computer-Aided Manufacturing
ZnPO4	Zinc Phosphate
EBP	Evidence-Based Practice
GIC	Glass Inomer Cement
OVD	Occlusal Vertical Dimensions
CR	Centric Relation
IODs	Implant Over Dentures

INTRODUCTION

A failure has been defined as the state or condition of not meeting a desirable or in- tended objective, and may be viewed as the opposite of success. **(Manappallil JJ et al., 2008)**

Several common scenarios are associated with dental malpractice.A dental record should include, but not be limited to: medical history (updated periodically), charting of restorations, tooth decay, missing teeth, occlusion, temporomandibular joint status, cancer screening, periodontal screening, presence of diseases and pathology in all forms, and radiographic records where indicated**. (Wittneben et al., 2013)**

Inadequate or no treatment planning is a frequent cause for dental malpractice. Deviations of the initial treatment planshould be clearly indicated. Dental records should at all times be adequate and contain exact and comprehensive descriptions of every procedure, event or interaction. With inadequate records the dentist will be at risk for being asked the following valid question by an attorney: “How can you testify as to what happened if your dental record does not detail the event and/or refresh your memory?” Written records should be in black ink if possible. **(Assaf A et al., 2017 and Williams et al., 2016)**

Replacement of missing teeth in partially edentulous arch involves various treatment options like removable, fixed prosthesis, and implants. Fixed prosthodontic treatment can offer exceptional satisfaction for both patient and dentist. Restoring and replacing of teeth with FPDs represents an important treatment procedure in dental practice, mainly because of the continuing high prevalence of caries and periodontal diseases in the adult and geriatric Populations. **(Turrell et al., 2012)**

Failure to achieve the desired specifications of design for function and esthetics would fail the prosthesis. Most of the time, the failures are conditions

that occur during or after performed fixed prosthodontics treatment procedures **(Vallittu PK et al., 2018)**

Failure of the fixed prosthesis can occur in many ways. The reasons for failure may be divided into biological failures, mechanical failures and esthetic failures. **(De backer al., 2006)**

Missing teeth can either be replaced by fixed or by removable implant supported prostheses. The clinical decision between the two differing types of restorations is based on anatomic, esthetic, and economic factors, and most importantly the wishes of the patient. High survival rates and low complication rates of the prostheses are an important prerequisite for the general success of treatment, as failures of the prosthesis may result in failures of the entire implant rehabilitation. **(Weigl P et al., 2019)**

One of the most important strategies to reduce the risk of failure is a comprehensive pretreatment diagnostic work-up followed by the decision to fabricate either a fixed or a removable implant prosthesis. According to the prosthetic plan the number of implants should be defined, as well as their ideal three dimensional prosthetic positions in the mesio-distal, bucco-oral, and vertical dimensions**. (Andreiotelli et al., 2010)**

In the case of single tooth gaps or partially edentulous areas framed by healthy neighboring teeth, fixed implant prostheses are usually indicated and the decision-making process is straightforward. In edentulous situations, however, the choice of fixed or removable implant prostheses is more complex. **(Buser et al., 2000)**.

Aims of review

1. Explain the failure concepts in prosthodontics
2. Exploring the reasons of failure concepts in prosthodontics.
3. Illustration maintenance of the prosthodontics.

CHAPTER ONE

Literature Review

Chapter one

Literature review

1. Types of prosthodontic failures and their causes

1.1 Failure of removable partial dentures

Failure of removable partial dentures is due to inadequate

1- Diagnosis and treatment planning

2- Mouth preparation procedures

3- Design of framework

4- Laboratory procedures

5- Support for denture bases

6- Occlusion

7- Patient-dentist relationship **(Rudd & Rudd. et al., 2001 and Pelekos et al., 2021)**

1- Diagnosis and treatment planning

Despite their effectiveness, RPDs can still fail due to various factors, including inadequate diagnosis and treatment planning. A thorough diagnosis should include a comprehensive medical and dental history, clinical examination, radiographic evaluation, and diagnostic casts. The diagnosis should also consider the patient's expectations, oral hygiene, and economic constraints. **(Fueki et al., 2011)**

Inadequate diagnosis can lead to various complications, such as incorrect choice of RPD design, inadequate retention and stability, and poor occlusion, which can result in RPD failure. Furthermore, the patient's underlying medical conditions, such as osteoporosis, diabetes, and autoimmune disorders, can also

affect RPD success rates. Therefore, a thorough diagnosis is crucial for the long-term success of RPDs. **(Haddad et al., 2017)**

Inadequate treatment planning can lead to RPD failure due to several factors, such as incorrect choice of RPD design, inadequate retention and stability, poor occlusion, and improper material selection. Additionally, RPDs may fail due to the lack of proper follow-up and maintenance care. **(Jorgensen et al., 2016)**

Therefore, the treatment plan should be comprehensive, including appropriate RPD design, material selection, occlusal scheme, and periodic recall visits to maintain the RPD's integrity. Recent advances in RPD treatment planning and materials have improved RPD success rates. For instance, digital technology has revolutionized RPD design and fabrication, making it more precise and predictable. Additionally, materials such as thermoplastic materials and CAD/CAM milled frameworks have improved RPD stability, retention, and comfort. Moreover, implant-supported RPDs have also shown promising results in improving RPD success rates. **(Turkyilmaz et al., 2016)**

2. Mouth preparation procedures

Mouth preparation procedures are essential for successful design and fabrication of removable partial dentures (RPDs). Soft tissue management and occlusal adjustments are two critical steps in mouth preparation that can significantly impact the success of RPDs. Failure to adequately manage soft tissues and adjust occlusion can lead to RPD failure, discomfort and reduced function **(Mc Cracken et al., 2016)**

Soft tissue management involves creating relief areas and selective pressure points to ensure RPD comfort and stability. The pressure points are designed to distribute forces evenly across the denture's bearing surfaces, while relief areas reduce pressure on the supporting soft tissues. Inadequate relief areas can result in tissue compression and irritation, while inadequate selective pressure points can lead to RPD instability and discomfort. **(Roccuzzo et al., 2014)**

Occlusal adjustments ensure that the denture's occlusal rests and occlusal stops are correctly placed to maintain proper occlusion and distribution of forces. Inadequate occlusal adjustments can lead to RPD instability, dislodgment, and premature wear. The placement of inadequate occlusal stops can result in increased stress on the remaining teeth, leading to their failure. **(Kawai et al., 2015)**

To prevent RPD failure due to inadequate mouth preparation procedures, clinicians should perform a thorough examination of the patient's oral cavity. Soft tissue management should be individualized to each patient's needs, with relief areas and selective pressure points placed in the right locations. Occlusal adjustments should be made using articulating paper and adjusted in a systematic manner until proper occlusion and distribution of forces are achieved. **(Fernandez et al., 2019)**

3- Design of framework

The framework design is a crucial factor in the success of removable partial dentures (RPDs). A poorly designed framework can lead to discomfort, instability, and reduced function, while a well-designed framework can improve patient outcomes and satisfaction. There are several reasons why RPD frameworks fail, including inadequate design, improper fit, and poor-quality materials. One of the primary reasons for framework failure is due to an inadequate design**. (Tan et al., 2008)**

The framework must be designed to fit the patient's mouth properly and provide adequate support for the artificial teeth. A poorly designed framework can cause discomfort, instability, and reduced function. Moreover, using cheap materials in framework design can contribute to failure. Low-quality materials may not be able to withstand the forces of chewing, leading to premature wear and damage**. (Fayyad et al., 2020)**

To prevent framework failure, dentists should perform a thorough examination of the patient's mouth before beginning the design process. The dentist should take accurate measurements of the mouth and consider the patient's unique needs and preferences. The framework should be designed to fit snugly against the patient's teeth and gums, providing proper support and stability**.** High-quality materials should also be used to ensure that the framework is durable and long-lasting. **(Strnad et al., 2019)**

Another strategy for preventing framework failure is to ensure proper fit. The framework must fit snugly against the patient's teeth and gums, providing proper support and stability. Proper fit can be achieved through careful planning and attention to detail. Dentists should take accurate measurements of the mouth and use advanced technologies, such as intraoral scanners, to ensure a precise fit**. (Siqueira et al., 2018)**

4- Laboratory procedures

The success of RPDs depends on various factors, including the laboratory procedures involved in their fabrication. Failure of RPDs due to laboratory procedures can occur if proper techniques are not used during the fabrication process. One of the main laboratory procedures that can lead to RPD failure is the impression-making process. The impression is critical as it forms the basis for the fabrication of the RPD. **(Bajraktarova et al., 2018)**

An inaccurate impression can lead to an ill-fitting RPD, which can cause discomfort, instability, and reduced function. The impression material should be carefully selected to ensure accurate reproduction of the oral tissues. Moreover, the impression should be taken with the patient's mouth in the same position as it will be when the RPD is worn. **(Negrutiu et al., 2017)**

The selection and placement of artificial teeth are also crucial factors that can lead to RPD failure. The artificial teeth should be chosen based on their shape, size, and color, ensuring that they match the natural teeth as closely as possible.

The teeth should be arranged in the correct occlusal relationship, and the denture base should be contoured to provide proper support and retention**. (Alageel et al., 2018).**

The laboratory procedures involved in the processing and finishing of the RPD can also contribute to failure. The RPD should be processed using high-quality materials and techniques to ensure durability and longevity. Care should be taken during the finishing process to avoid any sharp edges or rough surfaces that could cause discomfort or irritation to the patient**. (Williams et al., 2016)**

5- Support for denture bases

The support for denture bases can be provided by the residual alveolar ridge, teeth, and mucosa. The residual alveolar ridge is the bony ridge that remains after teeth have been lost. The ridge provides support for the denture base by distributing the load of mastication evenly. However, resorption of the ridge over time can lead to loss of support for the denture base.The teeth adjacent to the edentulous space also provide support for the denture base**. (Gonda et al., 2017)**

The support provided by teeth is critical in stabilizing the RPD, preventing displacement during mastication. However, if the teeth are weakened or compromised due to decay, periodontal disease, or trauma, the support provided may be inadequate. The mucosa also plays a role in supporting the denture base**. (Khan et al., 2017)**

The mucosa is the soft tissue lining of the oral cavity and provides support for the denture base in areas where the residual alveolar ridge and teeth are absent. However, the mucosa is susceptible to trauma, irritation, and inflammation, which can lead to discomfort and loss of support for the denture base**. (Koyano et al., 2016)**

One of the main causes of failure of RPDs is inadequate support for the denture base. A lack of support can cause the RPD to become unstable, leading to discomfort, difficulty eating, and reduced function. Moreover, inadequate

support can lead to pressure points on the underlying tissues, causing tissue damage and irritation**. (Tallgren et al., 2018)**

To prevent failure of RPDs due to inadequate support for the denture base, careful attention must be given to the support provided by the residual alveolar ridge, teeth, and mucosa. In cases where support is compromised, additional measures may be needed to ensure adequate support, such as implant placement or bone grafting**. (Khan et al., 2017)**

6- Occlusion

Failure of RPDs due to occlusion can occur in several ways. One of the most common causes is an incorrect distribution of occlusal forces. If the occlusal forces are not distributed evenly, it can cause excessive pressure on certain teeth, leading to discomfort and potential fracture of the teeth or denture components.

Additionally, occlusal forces can cause damage to the residual alveolar ridge, leading to resorption and loss of support for the RPDs**. (Cunha et al., 2017)**

Another potential cause of failure due to occlusion is an improper vertical dimension. The vertical dimension refers to the distance between the upper and lower jaws when the teeth are in contact. An incorrect vertical dimension can cause discomfort, instability, and potential damage to the supporting tissues. **(Latta et al., 2018).**

Additionally, occlusal interferences can cause failure of RPDs. Occlusal interferences refer to any contact between the upper and lower teeth that prevent proper occlusal forces distribution. This can lead to excessive pressure on specific teeth, causing discomfort and potential fracture**. (Muddugangadhar et al., 2017)**

Moreover, parafunctional habits such as bruxism and clenching can cause RPD failure. These habits can cause excessive forces on the RPD, leading to component fracture or damage to the supporting tissues. **(Tanimoto et al., 2015)**

To prevent failure of RPDs due to occlusion, careful attention must be given to the occlusal design during the fabrication process. The occlusal design should

ensure even distribution of occlusal forces, proper vertical dimension, and elimination of occlusal interferences. Additionally, any parafunctional habits should be identified and addressed through appropriate treatment. **(Khan et al., 2017)**

7- Patient-dentist relationship

The relationship between patients and dentists plays a critical role in the success of removable partial dentures (RPDs). A positive and collaborative patient-dentist relationship can lead to better patient compliance and improved outcomes. **(Bergendal et al., 2018)**

On the other hand, a negative or non-collaborative relationship can lead to RPD failure and dissatisfaction for the patient. One of the most significant factors affecting the patient-dentist relationship is communication. Good communication between the patient and dentist can help ensure that the patient's concerns and expectations are heard and addressed appropriately. **(Chai et al., 2016)**

Patients who are informed and understand the RPD treatment process are more likely to comply with treatment recommendations, which can lead to better outcomes. **(Jabero et al., 2016)**

Another crucial factor is patient motivation. Patients who are motivated and invested in their RPD treatment are more likely to be compliant with follow-up appointments and oral hygiene instructions, which can help prevent RPD failure. **(Wong et al., 2014)**

In contrast, patients who lack motivation may neglect their oral hygiene, leading to gum disease and loss of support for the RPD. Additionally, the patient's psychological factors can play a role in RPD failure**. (Awad et al., 2011)**

Patients with anxiety or depression may have difficulty adapting to RPDs and may be more prone to dissatisfaction or rejection of the prosthesis. It is essential for dentists to be aware of these psychological factors and address them appropriately to improve patient outcomes**. (Bedrossian et al., 2019)**

Furthermore, the patient's lifestyle and habits can affect the success of RPDs. Patients who smoke, consume alcohol excessively, or have a poor diet may be at higher risk for oral health problems, which can lead to RPD failure. It is important for dentists to address these lifestyle factors and provide appropriate counseling to improve the patient's oral health**. (Kaur et al., 2015)**

1.2. Failure of Fixed Partial Denture

A complication has been defined as "a secondary disease or condition developing in the course of a primary disease or condition." Although complications may be an indication that clinical failure has occurred, this is not typically the case. Knowledge regarding the clinical complications that can occur in fixed prosthodontics enhances the clinician's ability to complete a thorough diagnosis, develop the most appropriate treatment plan, communicate realistic expectations to patients, and plan the time intervals needed for post-treatment care**. (Hua et al., 2020)**

1.2.1 Most common failure in fixed partial denture and its management

- **Biological Failures**

1) Caries: Most common biologic failure. Detected by:

- Visual examination (check for discoloration around margins)
- Comprehensive probing of margins.
- Radiographs for interproximal surfaces.

Treatment: - Meticulous oral hygiene especially in patients with high caries index. Fluoride mouth washes, dentifrices, professionally applied topical fluoride and diet counselling. Antibacterial cements ($ZnPO_4$) and anti-microbial agents (Consepsis) should be used to decrease the caries incidence. Conventional operative dentistry procedures to restore small lesions. (**Poonacha et al., 2015)**

2) Pulp Degeneration

Clinical features: Pulpal sensitivity, intense pain, radiolucency in the periapical region, indicate pulpal involvement.

Treatment:-Use of varnishes and dentin bonding agents which forms an effective barrier and prevents underlying pulp from toxic effects of cement and core materials. Endodontic treatment of the involved tooth by making an access opening through the crown, once obturated the perforation can be restored with gold foil, amalgam or cast metal inlay. **(Yeo et al., 2018)**

3) Periodontal Breakdown

Clinical features: - Gingival recession, furcation involvement and pocket formation, mobility (secondary feature).

Treatment:-Proper oral hygiene instructions

In cases of less severe breakdown treatment is done by scaling and proper plaque control. In more severe cases treatment involves flap surgery, bone grafts etc. **(Al-Mardini et al., 2013)**

4) Occlusal Problems

Clinical Features:- Large wear facets, mobility, tender on percussion, open contacts, perforation, cusp fracture, tenderness of the masticatory muscles involved and in radiographic examination widened periodontal ligament is seen. **(Aslam et al., 2013)**

Treatment: - Mobility due to increased occlusal forces should be tested by Fremitus test. However trauma from occlusion on teeth previously weakened by periodontal disease or long term presence of occlusal forces on teeth with normal bone support can lead to mobility which cannot be reduced or eliminated through occlusal adjustments. **(Sadid et al., 2010)**

Patient with bruxism/clenching: - a night guard, or an occlusal splint should be given. Articulated diagnostic casts should be periodically remade and

compared with previous records so that any occlusal changes can be monitored and corrective treatment initiated. Selective reshaping of defective contacts and restoring or replacing teeth in more favourable position to accommodate occlusal forces. **(Al-Dwairi ZN et al., 2016)**

5) Tooth Perforations

If perforation located occlusal to periodontal ligament it is often possible to extend the tooth preparation to cover the defect. If below periodontal ligament then periodontal ligament is surgically exposed and restorations smoothened or place a restoration in the perforated area. If not accessible – extraction is done. Usually these perforations are not obvious initially during insertion of prosthesis, becoming obvious only at a later stage**. (Shah et al., 2016)**

- **Mechanical Failures**

1) Loss of Retention

Mainly due to leverage and unequal occlusal loads on different parts of the bridge, loose retainers cause rapid destruction of the abutment core which is usually made of dentin without its protective enamel cover. Saliva and plaque and pumping action of loose retainer are responsible for caries leading to rapid destruction of abutment teeth**. (Vojdani et al., 2019)**

Treatment:- Re-cementation if there is no extensive damage provided cause can be identified and eliminated. If the failure is due to poor preparation of the abutment then provide additional retention by cross pinning, grooves, and boxes etc. although ideally it should be made more retentive by fabricating new prosthesis. **(Zarone et al., 2017)**

2) Connector Failure/ Solder joint failure

Connector between an abutment retainer and a Pontic or between pontics can fracture under occlusal forces. Failure of both cast and soldered connection

has been observed and generally caused by internal porosity that has weakened the metal. **(Arora et al., 2021)**

Treatment:- Fracture connectors are difficult to detect in an abutment teeth with no mobility. Wedges are placed beneath the connector to separate the FPD components to conform diagnosis. Occasionally an inlay like dovetailed preparation can be developed in metal to span the fracture site and casting can be cemented to stabilize the prosthesis. **(Cakarer et al., 2012)**

If this is not possible and remake cannot be rapidly accomplished, the Pontic should be removed by cutting through intact connector. A temporary removal partial denture can then be constructed to maintain existing space and satisfy esthetic requirements**. (Sharma et al., 2016)**

It is better whenever possible to join multiple unit bridges by solder joint in the middle of pontics before porcelain is added. This gives much larger surface area for the solder joint and it is also strengthened by porcelain covering. **(Rangarajan V et al., 2017**)

3) Occlusal Wear and Perforation

Clinical features: Attrition of the opposing teeth, polished facets on the retainers/pontics, gingival recession or inflammation.

Treatment: - If perforation is detected early a gold/ amalgam restoration can be placed that seals the area and provide additional years of service. Other material are resin, composite, GIC. If perforation is over amalgam core, leave it untreated and check it periodically. If metal surrounding perforation is extremely thin a new prosthesis should be fabricated. If occlusal surfaces are covered with porcelain, wear of ceramic is usually not a problem instead the opposing natural teeth shows dramatic wear of enamel**. (Lang NP et al., 2007)**

4) Tooth Fracture

a) Coronal fracture: - Coronal tooth fracture can be dramatic, resulting in considerable loss of tooth structure or minor with little significant damage.

Treatment: - If defect is small it is restored with amalgam, gold foil or resin which may provide additional years of service even though not ideal. If defect is large a new prosthesis is fabricated so that it encompasses the fracture area. **(Zarone et al., 2017)**

b) Root fractures: - Located well below alveolar bone so the tooth must be extracted and new prosthesis fabricated. Occasionally fracture terminates at or just below the alveolar bone, in such cases it may be possible to perform periodontal surgery, remove bone and expose the fracture site so that it can be encompassed by new prosthesis.

(Sharma et al., 2016)

5) Porcelain fracture: Fracture occurs with both metal ceramic and all ceramic restoration. Majority of metal ceramic fracture can be attributed to improper design of metal framework or problems related to occlusion. All ceramics most commonly fail because of deficiencies in tooth preparation / due to heavy occlusal load**. (Rangarajan V et al., 2017)**

Treatment:

1) Best method is fabrication of new prosthesis

2) Resin materials are often used to rebuild the porcelain form in area where fracture has occurred, adequate to good color matches can routinely be achieved.

Drawback is lack of longevity and discoloration. (Even light cure composite can be used). Silane coupling agents or 4 Meta should be used to promote bonding with acrylic or composite. But strength of the joint diminishes with changes in temperature and prolong water storage.Retention is mainly

through mechanical means, therefore not used in areas of heavy occlusal force. **(Neppelenbroek et al., 2016)**

3) If fracture is due to heavy occlusal forces, the contact should be avoided at the metal ceramic junction and it should be at least 1.5mm away from the junction.

4) A more permanent repair is possible when adequate metal thickness is available. Steps involved are:-

a) Remove remaining porcelain

b) Drill several pin holes (4 to 5) to depth of 2 mm and make impression.

c) Creating pin retained metal casting 0.2 to 0.3 mm thick out of a metal ceramic alloy to fit over exposed metal framework.

d) Fusion of porcelain to the pin retained casting and establish normal form.

e) Cementation of casting in position**.**

5) If there is any risk of pontic area flexing, porcelain should be carried on to the lingual side of the pontic to stiffen them further.

6) Sleeve crown: When a considerable portion of porcelain is lost from labial/ incisal surface of a retainer or pontic it is often possible to repair than replace the entire unit. **(Rangarajan V et al., 2017)**

1.3. Prosthetic failures in dental implant prosthesis

The prosthetic complications can be considered as technical or mechanical complications. The technical complications represent those relevant to laboratory-fabricated parts such as fracture and chipping of the veneering materials, whereas mechanical complications represent complications relevant to the prefabricated parts, such as implant fracture or abutment failures**. (Salvi GE, Bragger U et al., 2009)**

1.3.1. Implant-Supported Fixed Dental Prostheses

a. Single implant-retained crowns

Metal-ceramic, single implant-retained crowns were the gold standard for decades, yet today all-ceramic implant crowns fabricated out of lithium disilicate or zirconia ceramics are successfully used as alternatives. The common technical complications for single implant-retained crowns are fracture or loosening of the abutment/prosthetic screws, loss of retention of cemented crowns, and chipping or fracture of the veneering ceramic. **(Alghamdi et al., 2016)**

The main reason for ceramic crown failure is complete fracture of the crown. Furthermore, fractures of ceramic implant abutments are considered as potential risk factors for the loss of implant-retained crowns. Finally, esthetic problems may occur with the different restorative materials (ie, metals and ceramics), leading to a failure of the implant treatment. **(Rabel K et al., 2018)**.

1. Fracture or loosening of retaining abutment/prosthetic screws

Screw loosening was and still remains the most frequent technical problem with single implant-retained crowns, with a cumulative 5-year complication rate of 8.8%. **(Jung RE et al., 2012)**

Crowns cemented to the supporting implant abutments suffered less from screw loosening than screw-retained crowns **(Sailer I et al., 2012)**

Further evaluation of the literature showed that both the crown design (screw-retainable or cementable) and the implant-abutment connections (external or internal) have a significant influence on the risk of screw loosening. **(Pjetursson BE et al., 2014)**

The stability of the screw joint can be influenced by the prosthetic implant axis. It has been shown that more screw loosening occurred with angulation-correcting implants than with straight implants. **(Hotinski E et al., 2019)**

Hence, the appropriate three-dimensional position of the implant is a crucial parameter with screw-retained implant prostheses to decrease the risk of complications. Furthermore, the number of retaining screws should be limited to one, as double screw systems exhibited a higher risk of screw loosening. **(Shin YG et al., 2016)**.

In addition, manufacturer-recommended torque values should be adhered to. **(Dincer Kose O et al., 2017)**

Finally, implants with internal implant-abutment connections are preferred to external connection systems, to reduce the risk of screw loosening. **(Pjetursson BE et al., 2018)**

2. Loss of crown retention

Loss of retention as a result of de-cementation is the second most frequent complication with implant single crowns. **(Jung RE et al., 2012)**

The restorative material plays an important role with incident technical problems. Metal-ceramic crowns are not dependent on adhesive cementation to the substrate (the abutment) in order to receive sufficient strength for clinical function as they already have excellent material stability. For this reason, metal-ceramic crowns are mainly cemented with conventional cements like zinc phosphate or glass-ionomer cement. Ceramic crowns exhibit a reduced fracture strength compared with metal-based crowns, and need to be chemically bound to the underlying substrate for improved clinical strength**. (Spazzin AO et al., 2016)**

Resin cements provide a chemical bond between the ceramic crowns and the underlying materials, thereby reinforcing the ceramic crowns. It has been shown that the 5-year rate for loss of retention of ceramic crowns was only 1.1 %. **(Rabel K et al., 2018)**

Whereas for metal-ceramic crowns the rate for loss of retention was five times higher at 5.5%, as reported in earlier reviews. **(Pjetursson BE et al., 2007)**

The main disadvantage of resin cements is that they are very viscous, mostly translucent, and not radio-opaque. In addition, they exhibit chemical bonding to the abutment substrate after curing. Hence, the removal of excess cement is significantly more difficult than with nonadhesive, opaque conventional cements. **(Squier RS et al., 2001)**.

To reduce the risk of complications associated with excess cement, screw retention of fixed implant prostheses is recommended. **(Sailer I at el., 2012) (Linkevicius et al., 2013).**

3. Chipping or fracture of the veneering material

Chipping of the veneering ceramic is the third most frequent complication with fixed implant prostheses**. (Pjetursson BE et al., 2014)**.

The framework material plays an important role in preventing high chipping rates. It has been shown that veneered alumina or lithium disilicate crowns experienced chipping in 1.8% and 3.5% of cases after 5 years of function, respectively, whereas veneered zirconia crowns exhibited very high chipping rates of 11.8% over the same time frame**. (Rabel K et al., 2018).**

By comparison, the incidence of chipping in metal-ceramic crowns was 3.5% **(Jung RE et al., 2012).** As shown in **figure (1-1)**

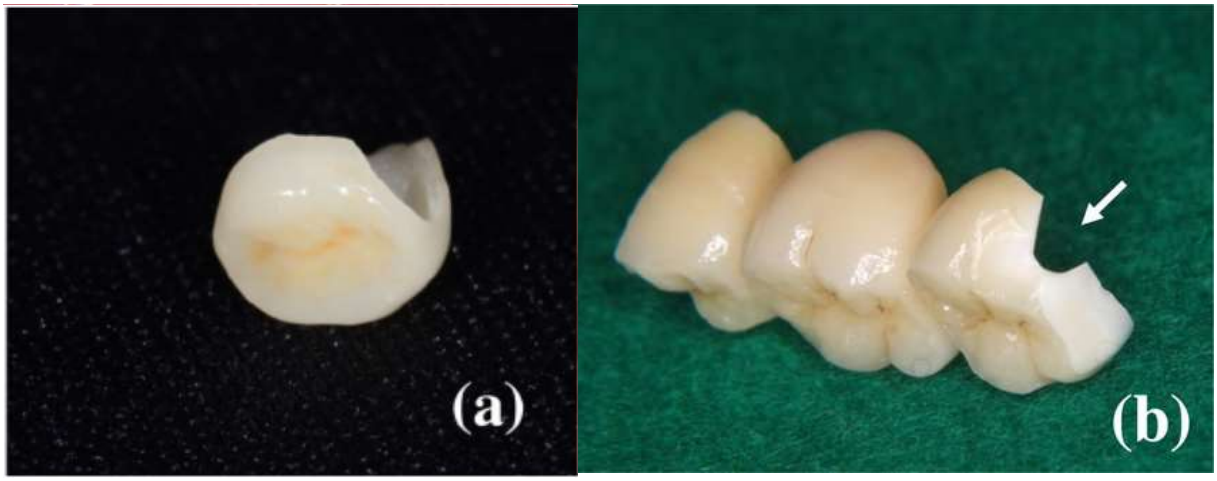

Figure (1-1) (a) Chipping of the ceramic veneer. (b) Framework fracture in the second upper left molar distal buccal. (Salihoglu U et al., 2011)

4. Fractures of ceramic abutments

Fracture of ceramic abutments is a rare complication.The reviews demonstrated no differences in the survival rates of metallic and ceramic implant abutments for implants with external connections. **(Sailer I al., 2009)**

Furthermore, no differences were found when comparing anterior and posterior regions**.**or internally and externally connected ceramic abutments.However, ceramic abutments exhibited more fractures than metallic abutments, a technical complication that inevitably leads to the failure of the implant restoration**. (Pjetursson BE et al., 2018)**

Fracture of an internally connected ceramic abutment predominantly occurs in the internal part of the implant-abutment connection, and in situations where the remnants cannot be removed from the internal connection, it may be necessary to remove the implant. For this reason, in internal connection implant systems, the application of ceramic abutments should only be recommended for the esthetic anterior regions. Nowadays, the combination of internally connected titanium-base abutments with zirconia abutments may serve as an alternative solution. **(Sailer I et al., 2018)**

b. Multiple-unit implant-fixed dental prostheses

In contrast to single implant crowns, the selection of materials for multiple-unit implant-fixed dental prostheses is limited to metal ceramics and zirconia ceramics. For multiple-unit fixed dental prostheses, zirconia displayed an inferior performance compared with metal ceramics, which are considered to be the gold standard. **(Pjetursson BE et al., 2015 and Sailer I et al., 2016).** In a recent review, metal-ceramic, multiple-unit, implant-fixed dental prostheses exhibited cumulative survival rates of 98.7%.

(Sailer I et al., 2018).

1. Chipping of veneering ceramic

Chipping of the zirconia veneering ceramic was found in 34.8% of multiple-unit, zirconia-fixed dental prostheses in one review. **(Pieralli S et al., 2018)** and in 50% of the fixed dental prostheses in another**. (Sailer I et al., 2018)**

Chipping of the veneering ceramic was reported for 8.8% of metal-ceramic, implant-fixed dental prostheses. **(Pjetursson BE et al., 2007)**

The monolithic zirconia, implant-fixed dental prostheses appear to offer a promising alternative. **(Carames J et al., 2019 and Weigl P et al., 2019)** as shown in **figure (1-2)**

Figure (1-2) Three-unit cemented, zirconia ceramic-fixed implant-supported FDP (iFDP) (Weigl P et al., 2019)

2. Fracture of zirconia frameworks

Fracture of zirconia frameworks was observed in 4.7% of restorations after 5 years of function, a complication that very seldom occurred with metal-ceramic, multiple-unit, fixed dental prostheses (0.2%). **(Sailer I et al., 2018)**

It has been shown previously that the size and the shape of the connectors are the most relevant parameters for the stability of multiple-unit, zirconia fixed dental prostheses. The new types of monolithic translucent zirconia ceramics exhibit better esthetic properties than the previous yttria-stabilized tetragonal

zirconia polycrystal framework materials, yet lower strength values. For predictable outcomes, manufacturers' recommendations need to be followed when designing these restorations. **(Zhang Y, Lawn BR et al., 2019)**

3. Screw loosening

Screw loosening is a rare complication with both the metal-ceramic and the zirconia-ceramic, implant-supported, multiple-unit fixed dental prostheses. Improvements in screw designs, screw materials, and torque values have led to a reported decrease complications. **(Pieralli S et al., 2018 and Sailer I et al., 2018)**

1.3.2. Implant-Retained Overdentures

1. Technical complications and prevalence

The technical complications of implant-retained overdentures can include overdenture failure or chipping of the veneering materials, whereas the mechanical complications include implant fracture, attachment failure, and attachment housing or insert complications**.** The available attachment systems can be classified into two main groups, namely, free-standing and splinted attachments. **(Salvi GE, Bragger U et al., 2009**). As shown in **Figure (1-3)**

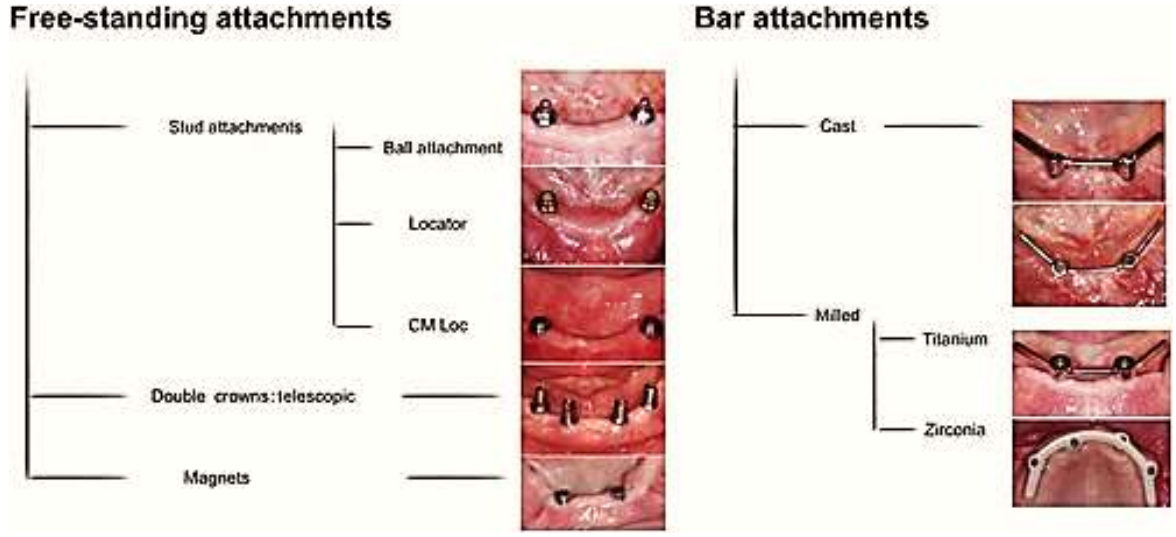

Figure (1-3) Summary of different implant-retained overdenture attachments types (Salvi GE, Bragger U et al., 2009).

A list of possible complications with implant-retained overdentures is provided in Table 1.

TABLE (1): Possible complications that may occur with implant-retained overdentures **(Walton TR et al., 2003)**

	Complication type	**Definitions**
Mechanical complications		
1	Patrix loose	Patrix component refers to stud attachments and/or its components as screws, as well as all inter-abutment and cantilever bars/superstructures (round, ovoid, U-shaped, milled, spark eroded)
2	Patrix activated	
3	Patrix replaced	
4	Patrix fractured	
5	Dislodged, worn, or loose matrix, or its respective housing	Matrix refers to O ring, resilient cap attachment, and magnets, as well as all types of metal alloy or plastic bar clips (single sleeve or multiple sleeve) or permanent resilient lining material connecting to inter-abutment or cantilevered bars/superstructures
6	Matrix activated	
7	Matrix replaced	
8	Matrix fractured	
Technical complications		
1	Fractured implant overdenture	Puncture fracture of acrylic resin over patrix or fractured denture teeth
2	Reline of implant overdenture	
3	New implant overdenture reconstructed	

a. Need of activation/loss/fracture of patrix or matrix retention component

The need for activation, replacement, or repositioning of a retention component, either the matrix or patrix, is the most frequently encountered event occurring with implant-supported overdentures in both jaws. **(Osman RB et al., 2012, Assaf A et al., 2017 and Goodacre C et al., 2017)**

"Time in function" is a more relevant factor than the attachment type. The incidence of a dislodged, worn, or loose matrix (or its housing) was more common after the first year with ball retainers, irrespective of the location of the implant overdenture. Nevertheless, the occurrence of other problems with attachments (eg, loosening or fractures) was not statistically different when the attachment types (ie, ball, bar, or magnet attachments) were compared for the first year of function and after 5 years. **(Cehreli MC et al., 2010)**

b. Screw loosening/screw fracture/abutment loosening

In a review of the literaturerated, the frequency of screw or abutment loosening encountered at implant-retained overdentures and found similar results for the different attachment types in both jaws. **(Cehreli MC et al., 2010)**

c. Fracture or replacement (fracture of acrylic resin, fractured denture tooth, fracture of framework or bar)/overdenture relining

The design of the implant overdenture, the location (jaw), and the time in function are relevant factors influencing the risk of technical complications. In the literature, maxillary implant-retained overdentures presented a high rate of technical complications when designed without palatal coverage or without a metal reinforcement **(Andreiotelli M et al., 2010 and Osman RB et al., 2012)**.

Bar fractures are rare technical complications; however, in the case of a bar failure, renewal of the prosthesis may be required. According to a literature review there are six reported essential causes for metal framework fractures, including implant overdenture bars. These are inadequate metal thickness, poor solder joints, excessive cantilever length, alloys with inadequate strength, patients' parafunctional habits, and improper framework design. Some of these are directly related to the bar itself, such as bar material, fabrication methods, or sensitivity**. (Kattadiyil et al., 2019)** as shown in **figure (1-4)**

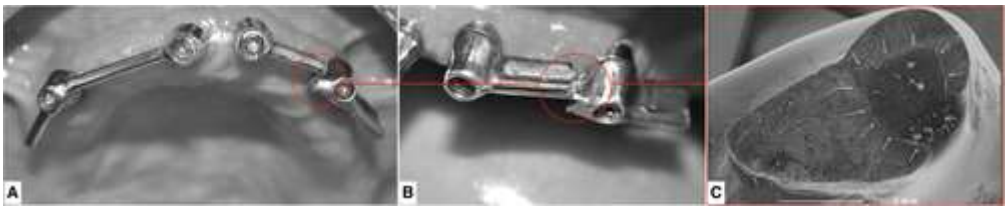

Figure (1-4) clinical presentation of patient with fractured cast bar.

(Kattadiyil et al., 2019)

Finally, the occlusal load and fabrication procedure have an impact on complications rates. The passive fit of prosthetic components and evenly distributed occlusal forces, without exceeding materials' resistance and eliminating parafunctional load, reduce the incidence of problems during aftercare. **(Andreiotelli M et al., 2010)**

2. Attachment type

Factors affecting the clinician's preference with regard to attachment types can be variable. A recent global survey of 116 prosthodontists from 33 countries showed that the most commonly preferred attachment type was the locator attachment **(Kronstrom M et al., 2017)** and clinicians often made their selection based on subjective criteria such as their expertise, personal comfort, and their dental technician's preference, or as influenced by marketing strategies. **(Naert I et al., 2003)**

Nevertheless, each attachment system comes with its own clinical prerequisites and has different indications. Existing prosthetic space, inter-implant distance, implant position and angulation, and number of implants are the main factors that should dictate the implant attachment of preference. Moreover, the maintenance requirements and complication rates arising can be related to such factors. **(Goodacre CJ et al., 2003 and Trakas T et al., 2006)**

The consequence of ill-positioned implants is, that the insertion path of the prosthesis and its fit will not be optimal, and this will result in a higher incidence of need for matrix change, or wearing of the patrix as shown in **Figure (1-5).** In

these cases, bar attachments are preferred to correct the axis deviations and achieve a better way of insertion. An incorrect selection of attachment will inevitably result in both higher maintenance requirements and complication rates **(Assaf A et al., 2017)**

Figure (1-5) Extensive wear of locator attachment as a result of implant misalignment (Assaf A et al 2017)

In a recent systematic review and meta-analysisreported that there was no significant difference in prosthetic complications between splinted and free-standing attachments. Although total complication rates did not differ, the observed complication types were different. With the bar attachments, fracture of the clip and overdenture were more common, whereas free-standing attachments (like the ball attachments) demonstrated both a greater need for matrix change and deformation of the plastic components. **(Leao RS, et al., 2018)**

3. Prosthetic material

A frequent technical complication in implant overdenture treatment is base fracture, hence, the design and materials play a crucial role in outcomes.

(ipahi C et al., 2006 and Chen KW et al., 2013)

Denture-base reinforcement is recommended to prevent technical complications of implant-retained overdentures, because it improves the implant overdenture stiffness and decreases denture-base deformation. Materials used for denture-base reinforcement are metal, high performance polymers, and carbon

and glass fibers as shown in **Figure (1-6)**. **(Weinlander M et al., 2010, Zou D, et al., 2013, Slot W et al., 2016 and Vallittu PK et al., 2018)**

Figure (1-6) Types of prosthetic reinforcements for IODS (Vallittu PK et al., 2018)

1.4 Esthetic Failure

- **Removable partial denture**
- **Fixed partial denture**

Ceramic restoration more often fail esthetically than biologically/ mechanically.

a) Color Mismatch: - Main reason reported by dental laboratories is poor color match. This could be the result of; - Inability to match the patient natural teeth with available porcelain colors. - Shade selection may have been inadequate. - Metamerism also leads to poor color match. - Insufficient tooth reduction / failure to properly apply and fire the porcelain may have created a restoration that does not match the shade guide or surrounding teeth. **(Cho GC et al., 2012)**

b) Facing failures: - Re-cementation of loose facing in metal ceramic bridges is simple process, but when fracture has occurred, a facing repair is indicated if prosthesis is otherwise satisfactory. A new facing can be ground to fit the prosthesis if the particular type of facing is still available. The adaptation of new facing is done on trial and error basis and often does not yield the ideal fit.

(lansa et al., 2016)

c) Esthetic failure: - It can also occur due to incorrect form or framework design that displays metal. In addition natural teeth undergo color changes that do not occur in porcelain, so that unacceptable color match is caused over the years. **(Rangarajan V et al., 2017)**

1.4.1 Esthetic Failure management

- **Implant prosthodontics treatment**

Esthetic problems can be a reason for the failure of implant treatment in specific clinical situations. A discoloration of the peri-implant mucosa, caused by implant parts or components, can be a major problem with implants in the esthetic zone (ie, maxillary anterior and posterior regions in patients with a high smile line). Therefore, recent studies have focused on the effect of different restorative materials on the color of the peri-implant soft tissues.

It has been shown that metallic abutments and metal-ceramic implant crowns caused a grayish discoloration of the mucosa in both laboratory and clinical studies. **(Jung RE et al., 2008)**

The amount of discoloration and its effect on esthetic outcomes may be associated with the thickness of the mucosa. A critical soft tissue thickness of 2 mm was defined, with a grayish shine-through of the metallic implant components in cases with thin soft tissues of < 2 mm. The color of tissues with thicknesses of > 2 mm was not influenced by the abutment or restorative materials. Hence, in esthetically important clinical situations, the clinical recommendation was to either use whiteish ceramic zirconia abutments and ceramic implant restorations in these cases, or to increase the thickness of the peri-implant mucosa to values > 2 mm with soft tissue grafts. Interestingly, recent studies showed that the bright white color of zirconia also induces a soft tissue discoloration, leading to brightening and a pale appearance of the tissues as shown in **Figure (1-7)**. **(Jung RE et al., 2007)**

Figure (1-7): Complete implant procedure of central incisor (Jung RE et al., 2007)

As has been shown, discolorations at the level of peri-implant soft tissues, as well as at the level of the implant restoration, can be perceived by both experts and laypersons. **(Sailer I et al., 2014 and Thoma DS et al., 2016)**

Therefore the esthetic outcome of implant restorations is key to their success. For this reason, several studies have focused on the ideal color of implant abutments and restorations. It has been shown that light pink or warm orange colors are more favorable than white. **(Ishikawa-Nagai S et al., 2007)**

The influence of recent ceramic materials (ie, the colored and translucent lithium disilicate and zirconia ceramics) used for monolithic implant single-unit and multiple-unit fixed dental prostheses has yet to be investigated**. (Benic GI et al., 2012)**

1.4.2 Color Stability of Facial Prostheses

The limited service of facial prostheses is the result of degradation of the elastomer and color instability. Deterioration may be caused by many factors, which include environmental exposure and changes in humidity. This

investigation assessed the efficacy of an additive, intrinsic, broad-spectrum ultraviolet light absorber on the color stability of a pigmented facial elastomer. Samples were weathered artificially and outdoors at exposure levels of radiant energy of 150 to 450 kJ/m^2. The samples changed color slightly but perceptibly. Artificial aging caused a greater change than outdoor aging. The ultraviolet light absorber UV-5411 did not protect the samples from color changes. **(Vallittu PK et al., 2018)**

1.5 Risk factors for prosthodontic failures

A. Risk factor of partial edentulism

1. Dyskinesia
2. Preexisting systemic conditions
3. Hyperactive gag reflex
4. Xerostomia
5. Increased salivation
6. Periodontal disease
7. Endodontic complications
8. Alveolar bone loss
9. Occlusal factors
10. Skeletal factors
11. Inadequate tooth structure
12. Parafunctional habits
13. Caries susceptibility
14. Psychosocial factors **(Rangarajan V et al., 2017)**

B. Risk Factors of complete edentulism

1. Dyskinesia
2. Preexisting conditions
3. Hyperactive gag reflex
4. Xerostomia
5. Increased salivation
6. Psychosocial factors. **(Koyano et al., 2016)**

C. risk factor for implant prosthodontics

1. Bone factors (quantity and quality)
2. Surgical
3. Implant characteristics
4. Anatomical considerations
5. Presence of active periodontal disease
6. Number of implants relative to number of teeth to be replaced
7. Interarch distance
8. Biomechanical loading factors
9. Presence of local or systemic conditions which affect healing (e.g., history of radiation therapy, diabetes, etc.)
10. Peri-implant tissue quality and contour
11. Proximity of implant site to adjacent structures
12. Existing and proposed occlusal factors
13. Tobacco use
14. Current and past pharmacological therapies **(Thoma DS et al., 2016)**

1.5.1 Risk factor for esthetic prosthodontics

1. Unrealistic patient expectations
2. Lack of clear communication
3. Existing systemic disease
4. Periodontal disease
5. Endodontic complications
6. Occlusal factors
7. Tooth position and alignment
8. Skeletal factors
9. Inadequate tooth structure
10. Soft/hard tissue architecture
11. Lip and cheek anatomy
12. Orofacial muscular complications
13. Psychosocial factors
14. Parafunctional habits. **(Rosentritt M et al., 2013)**

1.6 Diagnosis and assessment of prosthodontic failures

An evaluation of existing restoration will lead to one of the three possible courses:

1. Leaving the restoration alone, if it is not causing any serious harm. Although this is the most common choice by far, it must not be arrived at by default. Instead a careful examination is necessary to rule out any defects.
2. Adjusting or repairing the fault.
3. Replacing the crown or bridge or the existing restoration which is amenable to modification.**(Sailer I et al., 2014)**

1.7 Prosthodontic treatment planning for complex cases with high risk of failure

Prosthodontists must conduct a thorough risk assessment for complex cases to identify potential risk factors that could lead to prosthodontic failure. Collaborative treatment planning can help ensure that all potential risk factors are identified and addressed, and that the treatment plan is tailored to the patient's specific needs and circumstances. Collaborative treatment planning involves a team approach to prosthodontic treatment planning, with input from other dental specialists, such as periodontists, oral surgeons, and endodontists**. (Balshi TJ et al., 2019)**

Use of Advanced Technology such as computer-aided design and 3D printing, can help prosthodontists plan and execute complex treatments with a high risk of failure. These technologies can provide detailed information on the patient's oral anatomy, which can help in the design and fabrication of dental prostheses. They can also be used to create surgical guides, which can help ensure accurate placement of dental implants. Prosthodontists must educate patients on the risks and benefits of various treatment options, as well as the importance of proper oral hygiene and maintenance. **(Kokubo Y et al., 2013)**

Patient education can help improve treatment outcomes and reduce the risk of prosthodontic failure. Predictive analytics involves the use of data, statistical algorithms, and machine learning techniques to identify patterns and predict future outcomes. Prosthodontists can use predictive analytics to analyze patient data and predict the likelihood of prosthodontic failure. This can help in the selection of appropriate treatment options, identification of high-risk patients, and development of personalized treatment plans**. (Rosentritt M et al., 2013)**

1.8 Prevention of prosthodontic failures through proper treatment planning and execution

This involves ensuring that the prosthesis is fabricated and installed with the utmost care and precision. Proper implant placement, prosthesis fit, and occlusion must be carefully evaluated and adjusted as necessary to ensure that the prosthesis functions properly and is comfortable for the patient. In addition to proper treatment planning and execution, maintenance and follow-up care are critical for preventing prosthodontic failures**. (Goodacre C. J et al., 2011)**

Regular check-ups and cleaning appointments should be scheduled to monitor the health of the implant and prosthesis and to identify and address any potential issues before they become more significant. Patients should also be educated on proper oral hygiene practices and instructed on how to care for their prosthesis to prevent damage or infection. The use of digital technologies, such as computer-aided design and manufacturing (CAD/CAM) and 3D printing, has revolutionized prosthodontic treatment planning and execution. These technologies allow for greater precision and accuracy in the fabrication of prosthesis and restorations, reducing the risk of errors and failures. Additionally, the use of digital technologies can help clinicians visualize and plan the implant placement and restoration design in advance, allowing for a more predictable and successful outcome**. (Wittneben J. G. et al., 2013)**

1.9 Material selection and its impact on prosthodontic failure rates

The success of a prosthodontic treatment, especially when a single tooth has to be restored, is based on the “correct” selection of the restoration material. However, the material selection is influenced by subjective factors, such as the patient’s desire for metal-free restorations, the dentist’s expectations for maximal stability, and the dental technician’s experience with a preferred material. These subjective factors may be detrimental, and lead to an “incorrect” material

selection. Each clinical situation has to be analyzed systematically by means of a decision tree to allow selection of the most appropriate restoration material. Long-term studies have shown similar results for full- and metal-ceramic crowns regarding stability and long-term success. **(Meirelles et al., 2015)**

Consequently, the choice of the material for a single tooth restoration is mainly based on four esthetic factors.

- The translucency of the neighboring teeth
- The brightness value of the neighboring teeth
- The available space in the buccal area
- The degree of discoloration of the abutment tooth.

(Shyamala et al., 2015 and Nematollahi et al., 2017)

However, for multi-unit fixed dental prostheses (FDPs) additional factors have to be considered for the choice of material. According to the systematic review of the long-term results of tooth-supported full- and metal-ceramic FDPs were evaluated. **(Sailer I et al., 2007 and Pjeturssonet al., 2018).**

Both systematic reviews calculated the incidence of biological and technical complications. The five-year survival rates for metal-ceramic crowns were 95.6%, for reinforced glass-ceramic crowns (eg, Empress; Ivoclar Vivadent) 95.4%, and for glass-infiltrated alumina crowns (eg, In-Ceram; VITA) 94.5%. There were no statistically significant differences between groups. Consequently, both full-ceramic as well as metal-ceramic crowns may be indicated for single tooth restorations. In contrast, metal-ceramic FDPs showed a survival rate of 94.4% after 5 years, while FDPs with ceramic frameworks had a significantly lower survival rate of 89.6%.When the literature search for the systematic review was performed, only a few studies on zirconia were published**. (Zhang Y et al., 2019)**

Nevertheless, the results could already reveal an interesting trend at that time. The failures of metal-ceramic FDPs occurred due to biological and technical

complications, while the failures of all-ceramic FDPs manufactured from weaker ceramics, eg reinforced glass-ceramics were due to fractures of the framework. In contrast, FDPs with zirconia frameworks showed similar technical and biological complication rates when compared to metal-ceramic FDPs**. (Thoma DS et al., 2016)**

However, a higher rate of ceramic fractures (chipping) was reported. The material selection of single tooth restorations mainly depends on esthetic factors, while the indications for all-ceramic FDPs are more complex and are influenced by mechanical aspects such as the stability and the length of the edentulous gap. All these factors interact closely with one another **(Spazzin AO et al., 2016)** as shown in **Figure (1-8).**

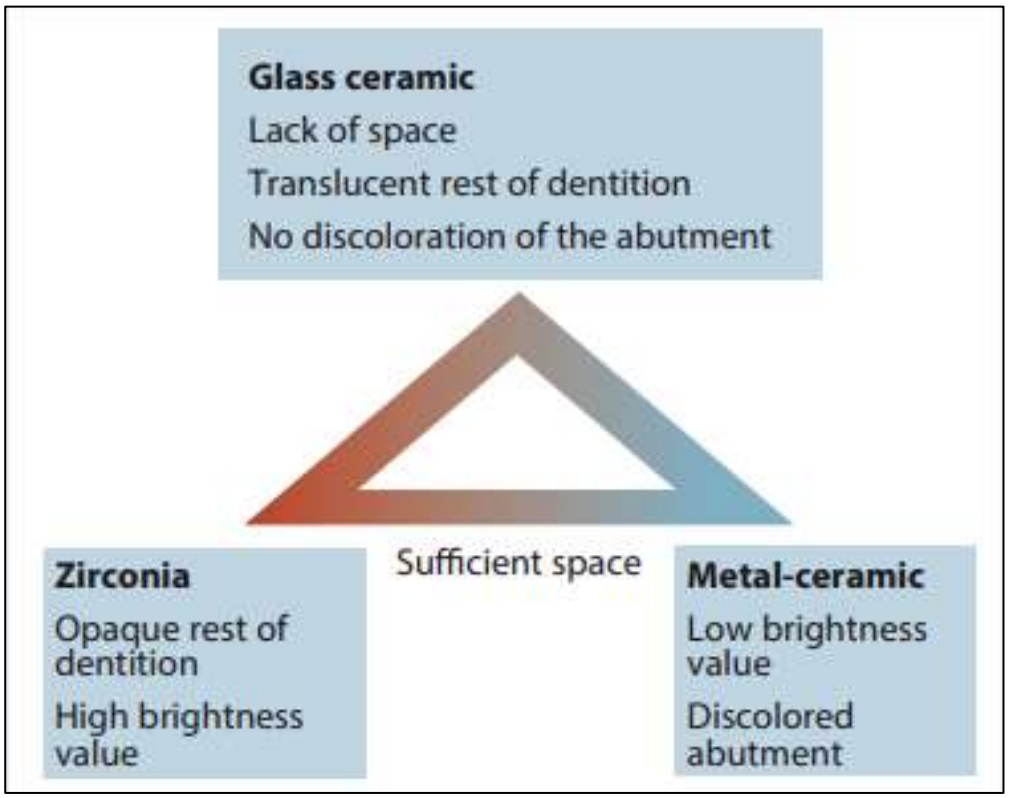

Figure (1-8): Decision matrix to evaluate the most appropriate restoration material (Spazzin AO et al., 2016)

The selection of materials for single-tooth crowns depends primarily on esthetic factors such as the color of the abutment tooth and the neighboring teeth,

as well as their brightness value and translucency. The breakdown of these factors can be easily achieved and categorized as shown in **Figure (1-9).**

However, with FDPs included in the spectrum, the length of the edentulous space is the most decisive factor for the selection of the reconstruction material as shown in **Figure (1-10)**.

Regarding the treatment with FDPs, short (three to four units) and long (five and more units) prostheses need to be differentiated. The longer the edentulous span, the more stable the framework required**.** For this reason, at present zirconia is the only all-ceramic alternative to metal frameworks. Recent results of a clinical study with an observation period of 10 years evaluating zirconia-based FDPs indicated that the risk for technical complications significantly increased with the length of the span. Accordingly, the risk for chipping of the veneering ceramic increases significantly with the length of the span. **(Sax C et al., 2011)**

These results suggest that with increasing edentulous gap size, a FDP with a metal framework should be preferred.

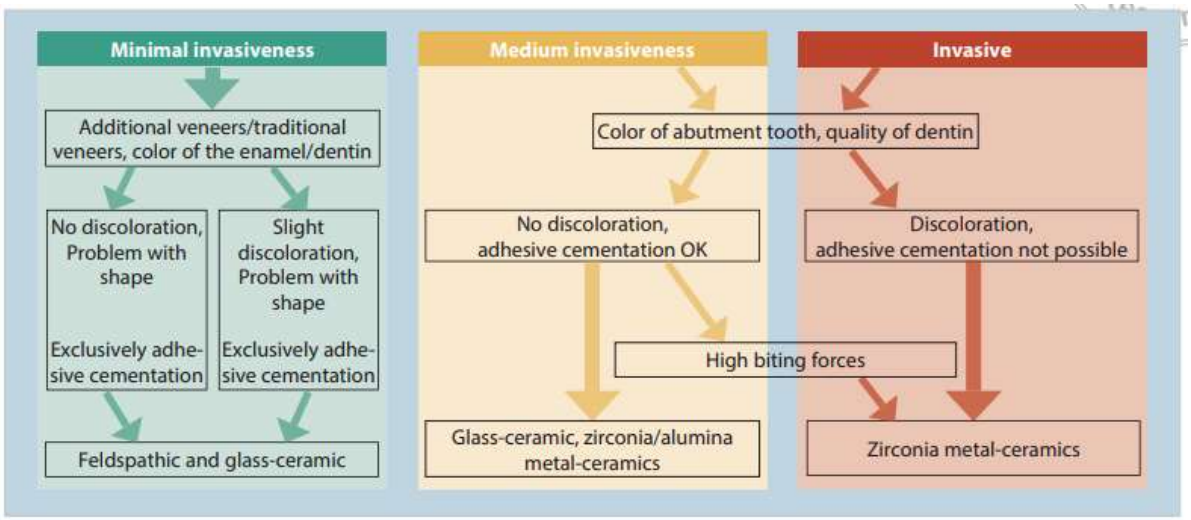

Figure (1-9): Decision matrix for single restorations determining the invasiveness of the treatment based on the material selection. (Fernandes et al., 2019)

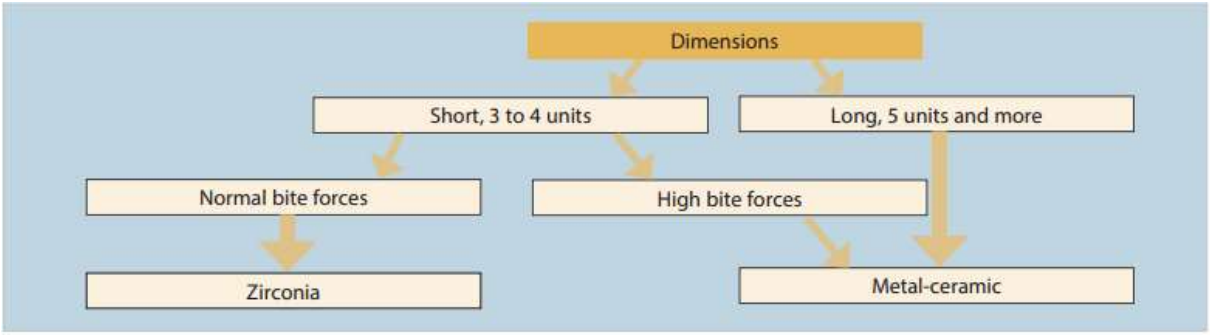

Figure (1-10): Decision matrix for FDPs determining the material selection based on the length of the span. (Turrell et al., 2012)

1.10 Clinical and laboratory techniques for reducing prosthodontic failures

1.10.1 Clinical Techniques

a. **Comprehensive examination**: A comprehensive examination can help identify potential problems that may lead to prosthodontic failures. The examination should include a thorough evaluation of the teeth, occlusion, temporomandibular joint, and periodontium **(Slot W et al., 2016)**

b. **Diagnostic wax-up:** A diagnostic wax-up is a valuable tool in treatment planning. It allows the clinician to evaluate the proposed treatment and make necessary adjustments before starting the actual treatment**.**

(Razak et al., 2013)

c. **Mock-up:** A mock-up is a temporary restoration that is placed in the mouth to simulate the final restoration. It allows the patient to evaluate the appearance and function of the restoration before it is fabricated. **(Sato et al., 2013)**

d. **Proper tooth preparation:** Proper tooth preparation is essential for the success of a prosthodontic restoration. The preparation should be conservative and should not compromise the structural integrity of the tooth. **(Heintze et al., 2018)**

1.10.2 Laboratory Techniques

a. **Digital technology:** Digital technology has revolutionized prosthodontic treatment planning and fabrication. Digital impressions, virtual articulation, and computer-aided design and manufacturing (CAD/CAM) systems can help reduce the incidence of prosthodontic failures.
b. **High-strength materials**: High-strength materials such as zirconia and lithium disilicate have become popular in prosthodontic restorations. These materials have high fracture resistance and can withstand the stresses of occlusion.
c. **Layered restorations:** Layered restorations are more esthetic and can mimic the natural tooth structure. They are fabricated by layering different shades and opacities of porcelain.
d. **Implant planning software:** Implant planning software can help the clinician plan the implant placement and restoration. It allows for the precise placement of implants and can help reduce the incidence of implant failures. **(Shin YG et al., 2016)**

1.11 Occlusal considerations in preventing prosthodontic failures

Proper occlusal considerations should be taken into account during prosthodontic treatment planning and execution to prevent prosthodontic failures. Proper registration of CR and establishment of the correct OVD are essential. Moreover, proper implant placement and restoration techniques can also affect the occlusion of the prosthesis and prevent prosthodontic failures. **(Shetty S et al., 2011)**

1.12 Impact of parafunctional habits on prosthodontic failures

Not only do the parafunctional behaviors affect the teeth, but they also have deleterious effects on dental protheses including dental bridges. Parafunctional

behaviors, particularly bruxism, can dislodge or damage dental bridges. The deleterious damage on dental bridges caused by persistent bruxism constitutes a major financial burden. Many researchers reported that bruxism was significantly associated with failure of fixed dental protheses on the long-term follow-up **(Al-Omiri et al., 2011 and Göstemeyer et al., 2016).**

Bruxism and parafunctional behaviors resulted in early damage and shortened survival of dental prostheses **(Sadowsky et al., 2012).**

Gold and ceramic materials are more preferred than resins by clinicians in treating patients with bruxism because they are more resistant to damage and substance loss **(Botelho et al., 2013).**

Along with the impact of parafunctional behaviors on fixed dental protheses, researchers stated that such behaviors, including bruxism, had shortened the longevity of removable partial dentures **(Creugers NH et al., 2010).**

As regards complete dentures, studies have depicted that bruxism had negative consequences on the residual dentition and denture-bearing tissues among those patients **(Papazoglou et al., 2018).**

Furthermore, using a protective night device for the fixed prothesis had improved the bruxism related complications among the studied patients**. (Persson et al., 2011)**

1.13 Role of digital technology in reducing prosthodontic failures

Although conventional techniques in dental care have worked excellently for decades, for a simpler, faster, more accurate, and more efficient workflow, there is a large potential in digital dentistry**. (Mattias T Et al., 2018)**

Digital dentistry refers to the use of dental technologies or devices that incorporates digital or computer-controlled components to carry out dental procedures rather than using mechanical or electrical tools**. (Paul L et al., 2011)**

There are many areas of digital dentistry available, and many more are being researched. Some of them are as follows:

1. Digital radiography
2. Intraoral imaging/optical impressioning
3. Computer-aided design/computer-aided manufacturing (CAD/CAM)
4. Shade matching
5. Digital smile designing
6. Virtual articulators and digital facebows
7. Laser
8. Occlusion and temporomandibular joint (TMJ) analysis and diagnosis
9. Photography – extraoral and intraoral
10. Practice and patient record management – including digital patient education.

- **Importance and advantages of digital dentistry**

1. Improved efficiency.
2. Improved accuracy in comparison to earlier methods.
3. A high level of predictability of outcomes. **(Torell Mottias et al., 2017)**

1.14 Management of failed prosthodontic treatments: Retreatment or replacement

The decision to retreat or replace a failed prosthesis should be based on a careful evaluation of the patient's needs and the potential risks and benefits of each option. The dentist should also consider the patient's financial resources, overall health, and long-term treatment goals when making this decision. Retreatment of a failed prosthesis is often the preferred option when possible**. (Javid B et al., 2013)**

Retreatment involves identifying the cause of the failure and addressing it while retaining the original prosthesis. In some cases, the prosthesis may need to

be modified or adjusted to correct the underlying issue. Retreatment can be more conservative, less expensive, and less time-consuming than replacement, making it an attractive option for many patients**. (Kois JC Et al., 2000)**

On the other hand, replacement of the failed prosthesis may be necessary in some cases. Replacement involves removing the failed prosthesis and fabricating a new prosthesis to replace it. This approach may be necessary when the failure is severe, and the original prosthesis cannot be salvaged. Replacement may also be necessary when the patient's oral health has changed significantly since the original prosthesis was placed, such as when there has been a significant loss of bone or other structures that support the prosthesis**. (Patel N et al 2013)**

1.15 Patient education on prosthodontic treatment outcomes and potential failures

One of the critical aspects of patient education is discussing the risks and benefits of the treatment plan. This includes discussing the potential for prosthodontic treatment failure, which can occur due to various reasons such as improper care, oral hygiene, and trauma. Patients should also be made aware of the maintenance required for their prosthetic appliances and advised on the necessary follow-up appointments**. (Pfeiffer et al., 2014)**

Another critical aspect of patient education is discussing the impact of oral health habits on the success of prosthodontic treatments. Patients should be encouraged to maintain good oral hygiene practices such as regular brushing and flossing to prevent complications such as gum disease and tooth decay that can impact the longevity of their prosthetic appliances. **(Swami et al., 2011)**

Patient education can also include discussing the importance of proper nutrition and the effects of systemic diseases such as diabetes on prosthodontic treatment outcomes. By educating patients on these factors, they can make

informed decisions and take steps to improve their oral and overall health**. (Khan M et al., 2019)**

1.16 Importance of follow-up and maintenance in preventing prosthodontic failures

Follow-up appointments also allow the dentist to monitor the patient's oral health, identify any risk factors such as oral hygiene instruction, the use of occlusal guards, or behavior modification therapy. By addressing these contributing factors, the risk of prosthodontic failure can be reduced. **(Kokubo et al., 2015)** and provide advice on oral hygiene and care. Early detection of complications can prevent the need for extensive and expensive treatments. Regular maintenance appointments are essential in ensuring the longevity of prosthodontic restorations. The dentist can examine the restoration, identify any signs of wear or damage, and perform any necessary repairs or adjustments. **(Ioannidis et al., 2016)**

Regular maintenance appointments can also help prevent the accumulation of plaque and calculus, which can lead to peri-implantitis, caries, or other complications. The dentist can educate the patient on proper oral hygiene techniques, the importance of regular dental visits, and the significance of adhering to the recommended maintenance schedule. **(Yildirim et al., 2011)**

1.17 Legal and ethical considerations in managing prosthodontic failures

The dental profession holds a special trust relationship with its patients. To uphold this mutual trust the dental profession makes a commitment to the patient that they will adhere to a high ethical standard of care and conduct. **(HPCSA Pretoria et al., 2008)**

The relationship between dentists and patients has changed in recent times and some of the major causes are: **(De Castro ACC et al., 2015)**

1. An increase in patient awareness of their rights.
2. High expectations and demands where aesthetic procedures are involved.
3. Competition between practitioners in a highly competitive market.
4. A change in the patient-dentist relationship from a personal/professional relationship to a more business/commercial relationship.
5. Increase in scientific and technological development creating a society founded on capitalism and consumption.

1.18 Prosthodontic research and development aimed at reducing failure rates

In clinical practice, it is imperative that the clinician provides the best treatment option with advanced techniques to their patients while considering the patient's request. Thus, the rendered treatment lives up to the highest of ethical standards. Evidence-based practice (EBP) involves utilizing strong scientific evidence that can be applied to queries that arise in daily practice. **(Shenoy et al., 2012)**

The concept was framed in 1991 and has been given the definition “the conscientious, explicit, and judicious use of current best evidence in making decisions about the care of individual patients.” Evidence-based practice involves treating a medical issue, with valid evidence that has been obtained from published studies. **(Faro-LeFevre R et al., 2013)**

Applying evidence-based medicine into practice enables us to correlate individual clinical signs, compare them with the treatment to other cases with similar problems, and take into consideration the best scientific evidence to date. Evidence based Medicine provides a Higher standard of patient care, better

treatment with minimal or no side effects, is economical and ultimately gives both the clinician and patient a greater degree of contentment compared to the traditional approaches of care. **(McGinty J et al., 2008)**

1.19 Future directions in prosthodontic failure concepts and prevention

Prosthodontics is a well-defined and broad dental specialty catering to a wide range of oral rehabilitative treatment needs of community. It is continuously evolving consequent to the rapid advancements in dental biomaterials science, clinical and laboratory techniques and technologies. The dynamic nature of our specialty, its current trends, innovative thoughts, emerging technologies etc. contributes to overall shaping the future of prosthodontics. **(John GP et al., 2016)**

- **Emerging common trends in prosthodontics are seen in:**

1. CBCT
2. CAD/CAM
3. Biomimetics
4. Nanotechnology
5. Electronic shade matching
6. Digital smile designing
7. Virtual articulators
8. Lasers
9. Robotics

CHAPTER TWO
Conclusion

Chapter two

Conclusion

1. Failure in prosthodontics is a complex and multifactorial phenomenon, influenced by a wide range of patient, operator, and material factors. The most common types of failure are mechanical and biologic in nature, and can result in a range of clinical complications and adverse outcomes.
2. Reasons for failure in fixed prosthodontics are related to the technical quality of the restoration, including improper preparation design, inadequate retention and resistance form, and poor fit of the restoration. Other factors, such as occlusal overload, material fatigue, and biologic factors, such as periodontal disease and caries, can also contribute to failure. In addition, patient-related factors, such as oral hygiene and compliance, can influence the long-term success of the restoration.
3. Maintenance is critical to the long-term success of prosthodontic restorations. Factors such as regular oral hygiene, appropriate occlusal adjustments, and timely repair of any damage or wear can help prevent failure. In addition, patient compliance and participation in the maintenance process is essential. Patients should be educated on the importance of regular follow-up appointments and instructed on how to properly care for their restorations at home. Furthermore, the use of appropriate materials and techniques during fabrication can also contribute to the longevity of the restoration. Overall, the maintenance of prosthodontic restorations is a collaborative effort between the clinician and the patient and should be given careful attention to ensure the success of the restoration over time.

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