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# Factors Influencing Abutment Selection in Fixed Partial Denture-A Review

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**Abstract:- Abutment selection for fixed partial denture is an important criterion for the success and longevity of the prosthesis. The forces acting on the prosthesis are dissipated along the abutments to the periodontal ligament. The major cause of failure includes inappropriate designing, taking improper materials for fabrication, insufficient tooth preparation, and not having enough knowledge regarding the biomechanics. Abutment selection for fixed partial dentures involves proper diagnostic ability and in-depth knowledge about the stomatognathic system. This article review about the diagnostic aspect and the factors influencing the abutment selection for a fixed partial denture, which aids in the long term success of the prosthesis.**

***Keywords:-*** *Abutment, Crown Root Ratio, Fixed Partial Denture, Occlusal Anatomy, Surface Area, Periodontium.*

## I. INTRODUCTION

Majority of the patients prefer fixed partial denture as a treatment modality for the rehabilitation of missing teeth. Fixed partial denture usually utilizes an abutment tooth on each terminal of the edentulous spaces which is needed to supportthe prosthesis.[1]Abutments bear the load of mastication and the choice of abutment determines the success of the prosthesis. Failure of the prosthesis occurs due to poor engineering, the use of inappropriate materials for fabrication, insufficient tooth preparation, and defective manufacturing. Among this the major concern of dentists is the abutment selection. Meticulous awareness about the anatomy, ceramics, the chemistry and physics of dental materials, metallurgy, Periodontics, phonetics, physiology, radiology and the mechanics of oral function is very indispensable for the success of the prosthesis.[2] Proper diagnosis and treatment planning are the first and foremost step which determines the longevity of the fixed partial denture. This article discusses about few diagnostic procedures and factors to be considered in the selection of abutments for a fixed partial denture.

## II. DIAGNOSTIC CASTS

Diagnostics casts must be properly oriented to the transverse hinge axis and to the plane of occlusion on an articulator and resembles the eccentric movements in the oral cavity. This articulation procedure provides a simple evaluation and correlation of occlusal relationship of both dental arches and the abutment teeth. Rotated teeth can be easily identified. The shape and position of the abutment teeth and the occlusion with the opposing teeth can be easily visualized.[3, 4]

## III. RADIOGRAPHIC EXAMINATION

Periapical and bitewing radiographs are very important in selection of the abutment teeth. Panoramic radiographs are very relevant for patients having temporomandibular joint dysfunction.[5]

An intraoral radiographic examination interprets:
- Bone support.
- Number of the root and root anatomy (long, short, slender, broad, bifurcated, fused, dilacerated etc.) and rootproximity.[5]
- Supporting bone quality, trabecular patterns and reactions to the functional changes.
- Periodontal ligament spaces and evidence of Trauma from occlusion.
- Areas of vertical and horizontal bone resorption and furcation involvement.
- Degree of the parallelism of the abutment teeth.
- Continuity and integrity of lamina dura.
- Morphology of the pulp and root canal treatment done previously with or without post and cores.
- Evidence of any apical pathology, root resorption or root fractures.
- Retained root fragments, areas of radiolucency, calcifications, existing foreign bodies or impacted teeth.
- Presence of carious lesions, the condition of restorations in the oral cavity, and vicinity of carious lesion to the pulp.
- Degree of closeness of carious lesions and restorations towards the alveolar crest.
- Deposits of calculus.[5]

## IV. FACTORS WHICH INFLUENCES THE ABUTMENT SELECTION

The preference of the abutments for fixed prosthesis are decided by a combination of load-withstanding capacity of the supporting teeth along with the forces and stresses to which they are exposed. The factors like root number, shape, length, alignment, and remaining bone height is directly proportional to the load- bearing capacity of the abutment teeth. Therefore, certain factors have to be considered before taking the teeth as an abutment.

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The factors influencing abutment selection are as follows:

- *Crown to root ratio*
- *Surface area*
- *Arch form*
- *Rigidity*
- *Margin location*
- *Occlusal anatomy*
- *Buccolingual dimension of teeth*
- *Pontic tissue contact*
- *Crown length*
- *Crown form*
- *Degree of mutilation of crown*
- *Root configuration*
- *Root proximity*
- *Alveolar ridge form*
- *Span length*
- *Mobility*
- *Phonetics*
- *Esthetics*
- *Age of patient*
- *Psychology*
- *Prognosis*

- *Crown Root Ratio (CRR)*

According to GPT 9 "the physical relationship between the portions of the tooth not within the alveolar bone, as determined by a radiograph, compared with the portion of the tooth within alveolar bone". As the alveolar bone level migrates apically, the lever arm of that portion out of the bone increases, and that can increase the occurrence of deleterious lateral forces acting on it. The optimum crown- root ratio for the abutment tooth is 2:3. The minimum acceptable ratio for an abutment under normal situations (such as numberof teeth being replaced, tooth mobility and overall periodontal health is good) is considered to be 1:1. Even though there are certain conditions where a crown root ratio greater than 1:1 might be acceptable. A 1:2 crown to root ratio is considered to be ideal.[1] As the crown to root ratio is purely based on linear measurement values, the clinician should also consider other factors like the alveolar bone height and the total supported root surface of the abutment tooth.[3] Dykema, proposed a 1:1.5 as an acceptable CRR for abutments. Although the authors dictated that this CRR ratio may be acceptable only in cases where the periodontium is inahealthy condition, and the occlusion is manageable.[6] When the edentulous span is longer and the forces acting on the abutment teeth are greater, the more favorable the crown-to-root ratio must be. The CRR can be compensated in conditions where multiple teeth are taken as abutment teeth.[3, 7]

- *Periodontal surface area*

ANTE's LAW (1971) was introduced by Ante (1926) and later proposed by Johnston, Dykema, Shillinburg, Tylman. The combined pericemental area of the abutment teeth should be equal to or greater to the pericemental area than the teeth to be replaced (Ante's Law). Multiple teeth abutment are indicated in situations where there is insufficient periodontal surface area, along with that other biomechanical factors has to be considered. Teeth having more surface area can withstand the additional forces in a better manner. Jepsen in 1963 has reported the root surface areas of the various teeth

| Root Surface Area ($mm^2$) | Maxillary | Mandibular |
|---|---|---|
| 1. Central Incisor | 204 (10%) | 154(8%) |
| 2. Lateral Incisor | 179(9%) | 168(9%) |
| 3. Canine | 273(14%) | 268(15%) |
| 4. I Premolar | 234(12%) | 180(10%) |
| 5. II Premolar | 220(11%) | 207(11%) |
| 6. I Molar | 433(22%) | 431(24%) |
| 7. II Molar | 431(22%) | 426(23%) |

According to this law, if there is a single missing teeth it can be successfully rehabilitated by considering two adjacent abutments for support. If twoteeth are missing, they can be replaced by taking two teeth as abutment for support, but the limit is being reached.

Nyman and Ericsson, however, raised a doubt on the validity of Ante's law. They proved their statement by showing that teeth with reduced bone support can also be considered as abutments. Among the various cases discussed by them, there was no evidence of attachment loss over a period of 8 to 11 years even if the abutment root surface area was lesser than half that of the replaced teeth. Nyman and Ericsson claimed that the reason behind this observation could be by the meticulous root planning done in the active phase of the treatment. They also added that proper plaque control in the course of observed period and proper designing of the occlusal aspect of the prosthesis was also important.[8]

- *Long axis relationship*

The long axis relationship of the abutment teeth should not be more than 25˚ to 30˚from parallel. The architecturedthe periodontal ligament is built in such a way that it can withstand the forces in a better way when they are transmitted through the long axis of the abutment teeth. A critically inclined tooth will not bear the stresses much when compared to an abutment which is moreover erect. The lesser the force and the shorter the edentulous span, the more a tooth may be inclined and still be considered as an abutment.[5]

- *Arch form*

Curvature of arch induces stress in FPD. Pontic outside the inter abutment axis induces torquing movement. Teethin different quadrants of the arch move in different directions. Because of the curvature of the arch, the faciolingual movement of the anterior tooth takes place at a considerable angle to the faciolingual movement of the molar.[9] FPDs comprising the anterior teeth are set in the shape of an arc. Whenever a force is applied on the pontics,a rotational effect will take place in the abutments, and a vertical force is exerted on the terminal ends of the fixed partial denture. The lever arm can be assessed by drawing a line perpendicular from the fulcrum line to the point on the farthest located pontics from this line. The fulcrum line is determined by drawing a line joining the abutmentsadjacent to the edentulous space at the proximo-occlusal angles of the preparation.[10]There will be more leverage in cases where the four maxillary incisors are

replaced in a narrow-tapered arch. The lever arm is shortened by the existence of a single incisor. By using additional abutments, a long lever arm can be equalized. For a maxillary four pontic canine to the canine fixed partial denture, sometimes first premolars are taken as secondary abutments. They exhibit excellent retention due to the tensile forces exerted to the premolar retainers.[10]

➢ *Rigidity*

Lack of rigidity of the prosthesis is one of the common causes of failure. Utilizing the right materials which are arranged in the exact shape, form and thickness with respect to the stresses acting upon them may aid in sufficient rigidity to the prosthesis. Flexure results in damage to the abutments and it may lead to eventual loosening of the retainers, and fatigue of the metal. The stresses produced should not overcome the yield strength of the alloy.[5]

➢ *Margin Location*

Sound tooth enamel cannot be enhanced biologically or esthetically. Therefore, finish lines should not be kept very close to the gingival tissues. The margin of any of any restorative material if extended beneath the free gingival margin will irritates the gingiva.[5]

➢ *Occlusal anatomy*

Occlusal anatomy has an indirect effect on the forces directed. The anatomical features like the ridges and grooves enhances the sharpness and shearing action of teeth and minimizes the friction between the opposing tooth surfaces by making the contact area narrow. This provides effective mastication and minimizes the forces transmitted. Stallard stated that the attrited teeth needs more muscular power and longer and more masticatory strokes to chew food efficiently.[11] Most of the force is directed perpendicular to the long axis of the teeth. Properly articulated ridge bearing cusps will grind the food efficiently, with lesser strokes, with minimal muscular effort.[10]

➢ *Buccolingual dimension of teeth*

The occlusal surface of the pontics should integrate with the buccolingual dimensions of the natural unmutilated teeth, and recreate the normal buccal and lingual form to the height of contour. By reducing the width of the pontics, the forces transmitted to the abutments are not decreased, rather it creates heavier stress per unit on the prosthesis.[2, 12, 13]

➢ *Mesio distal dimensions of teeth*

The total mesiodistal width of the cusps of abutments should either equivalent or more than the width of the cusps of pontics. This correlation ensures that the occlusal load transmitted to the abutment teeth will not be more than twice the amount usually supported by these teeth individually.

➢ *Pontic - tissue contacts*

The tissue-contacting surface on pontics should be convex, smooth, and devoid of porosity. The contacting areas should be minimal, pressure less, and should have saliva contact rather than tissue contact.

➢ *Crown length*

Inorder to provide adequate retention, the abutment teeth should have adequate length. Additional abutments are required for pontics having increases occlusogingival height. Splinting of the multiple abutments should be done inorder to obtain support for the teeth having crown height <4 mm.

➢ *Crown Form*

To enhance retentive and esthetic qualities full coverage retainers are essential for teeth having tapered crown form as it will interferes with parallelism of the preparation. Egs: anterior teeth with poorly developed cingula and short proximal walls and mandibular premolars with lack of well-developed lingual cusps and short proximal surfaces. Partial coverage retainers are esthetically unacceptable for incisors having very thin highly translucent incisal edges.[5]

➢ *Degree of mutilation of crown*

The type of retainer on abutment tooth is depended on the degree, type and size of carious lesion. A caries free and an unrestored tooth is considered as an ideal abutment. For grossly destructed teeth, alterations like dowel core and pin retained amalgam restorations are required to reinstitute crown shape and form.

➢ *Pulpal health*

Vital teeth are usually selected because of their better proprioceptive feature. Absence of adequate pulpal heath can lead to failure of the prosthesis. Prophylactic root canal treatment may be needed before the restoration.[10]

➢ *Root configuration*

For a short span fixed partial denture the tooth with conical roots are preferred if all other factors are optimal. Tooth with longer root is considered to be a stronger abutment than with short roots. Labiolingually conical roots are more anchored than circular roots. Apical divergence of the root must exceed the apical convergence.[12]Widely separated multirooted posterior teeth are more preferred compared to the conical or fused root. On comparison with smooth sided conical roots, parallel sided roots with developmental grooves exhibits better resistance to additional forces.[14]

➢ *Root Proximities*

In order to allow the formation of physiologic embrasures in the completed prosthesis adequate clearance between the roots of the suggested abutments are necessary. Proper embrasure form is not possible in cases where the anterior teeth are malposed and in the mesiobuccal roots of the maxillary molars. In such conditions selective extraction or root resection procedures may be the only approach to improve the longevity of the restoration.[5]

➢ *Alveolar Ridge Form*

The ideal ridge configuration should be flat and wide. Extreme resorption results in the development of low and thin ridges, accompanying high pontics and additional torsional forces.[5]

➢ *Span length*

Bending or deflection is equivalent to the cube of the length with the cube of the occlusogingival thickness of the pontic.[1]Long-span FPDs creates more flexion. In 1934, Stuteville experimented and proved that

$$\text{Bending (deflection)} \quad \alpha \quad \frac{\text{Length}^3}{\text{Occluso-gingival thickness}^3}$$

Fixed partial denture with a two-tooth pontic span will shows bending or deflection 8 times as compared with a single tooth pontic span. Likewise a three-tooth pontic will bend 27 times compared to a single pontic.

This flexure can be reduced by:

- Increased occlusogingival thickness of pontics
- Bulky pontics
- Bulky connectors
- Materials with high yield strength

➢ *Mobility*

There have been evidences that teeth with insufficient periodontal support can also be considered as an abutment for fixed partial denture. Teeth having profound bone loss and noticeable mobility have been used as an abutment. Instead of eliminating the mobility, stabilization of the teeth is the chief goal to prevent further progression of mobility.[15, 16]

A Miller mobility value of one is usually allowable, but when the mobility value is two, it requires additional evaluation. If the mobility is associated with deflective occlusal contacts and if length of the span is short, then the tooth can be considered as an abutment. If mobility is associated with significant bone loss and in conditions where more than one tooth has to be replaced, the tooth is not taken as an abutment unless it can be splintedto another sound tooth. Abutment having Millers mobility value of three is not acceptable. [5]

➢ *Phonetics*

Abutments selected for fixed partial denture should not be bulky as it may interfere with the phonetics.[10]

➢ *Esthetics*

Better esthetics and retention are obtained by the full coverage crowns. Anterior abutments having long connectors will also ensures good esthetics.[10]

➢ *Age of the Patient*

For adolescent patients fixed partial denture is usually not indicated as the teeth are not completely erupted or when the pulp chambers are larger which can interfere with retentive preparations. In such situations a space maintainer should be provided to the patient in order to keep the abutments and opposing teeth in position. Nevertheless minimal tooth preparation is done and the prosthesis is considered as a temporary treatment option and has to be remade when the pulp size permits.[5]

➢ *Psychology*

For mentally disabled patients multiple splinted abutments may be required. Splinted abutments offer distribution of harmful parafunctional forces.[10]

➢ *Prognosis*

The prosthesis should last for at least 60% of the time in the span of 20 years.[10]

## V. CONCLUSION

Abutment selection influences the longevity of the prosthesis. They withstand the forces of mastication. To conclude, the necessity of selecting an appropriate abutment for the fixed partial denture cannot be exaggerated.It forms the foundation for the treatment planning for fixed partial dentures and the proper selection and tooth preparation aids in longevity of the prosthesis.

## REFERENCES

[1]. Shillingburg HT, Sumiya H, Whitsett LD, Richard J, Bracket SE. Fundamental of Fixed Prosthodontics.3rd ed. ChiCago: Quitessence Publishing Co. Inc.; 2010.
[2]. Reynolds JM. Abutment selection for fixed prosthodontics. Journal of Prosthetic Dentistry. 1968 May1;19(5):483-8.
[3]. Kalra D, Kalra A, Goel S. Anthrometric measurements of external ear: An in vivo study. InternationalJournal of Enhanced Research in Medicines & Dental Care. 2015;2(3):10-6.
[4]. Singh S, Singh N. Treatment planning for fixed partial dentures. Int J Oral Health Med Res. 2015;2(2):99-101.
[5]. Chansoria S, Chansoria H. Abutment selection in fixed partial denture. IOSR Journal of Dental and Medical Sciences (IOSR-JDMS). 2018;17(3):4-12.
[6]. Dykema RW. Fixed partial prosthodontics. J Tennesee 1962;42:309-21.
[7]. Penny RE, Kraal JH. Crown-to-root ratio: its significance in restorative dentistry. The Journal of prosthetic dentistry. 1979 Jul 1;42(1):34-8.
[8]. Nyman S, Ericsson I. The capacity of reduced periodontal tissues to support fixed bridgework. Journal ofclinical periodontology. 1982 Oct;9(5):409-14.
[9]. Grossmann Y, Sadan A. The prosthodontic concept of crown-to-root ratio: a review of the literature. The Journal of prosthetic dentistry. 2005 Jun 1;93(6):559-62.
[10]. Subhashini MR, Abirami G, Jain AR. Abutment selection in fixed partial denture-A review. Drug Invention Today. 2018 Jan 1;10(1).
[11]. Stallard H. The Good Mouth – A Syllabus on Oral Rehabilitation and Occlusion. Vol. 1. San Fransisco: University of California;1959.
[12]. Sharma A, Rahul GR, Poduval ST, Shetty K. Assessment of various factors for feasibility of fixed cantilever bridge: A review study. International Scholarly Research Notices. 2012;2012.
[13]. Dawson PE. Evaluation Diagnosis and Treatment of Occlusal Problems. 1st ed. ST. Louis: CV MosbyCo.; 1974.

[14]. Johnson JF, Phillips RW, Dykema RW. Modern Practice in Crown and Bridge Prosthodntics. 2nd ed. Philadelphia, PA: W.B. Saunders Company; 1965.
[15]. Nyman S, Lindhe J. Prosthetic rehabilitation of patients with advanced periodontal disease. Journal of clinical periodontology. 1976 Sep;3(3):135-47.
[16]. Nyman S, Lindhe J, Lundgren D. The role of occlusion for the stability of fixed bridges in patients withreduced periodontal tissue support. Journal of Clinical Periodontology. 1975 Jun;2(2):53-66.