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Review Article

Kennedy Class II Problems and Treatment Options: A Review of Literature

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Abstract:

Kennedy Class II is of the most difficult to restore cases. It needs a very good design to overcome the most common problems of this class, such as the support problems resulting from its combined tooth-tissue support nature. In addition to the unilateral nature which results in problems with its bracing and stability. Most commonly, is the retention problems as well. Additionally, other potential problems are abutment teeth mobility as well as decreased masticatory efficiency. In an effort to overcome the above-mentioned challenges, special techniques, and new modalities in RPDP treatment have been proposed to enhance its success. This includes special impression techniques, alternate RPDP designs such as the mesial rest combined with a proximal plate and I-bar (RPI) system. Other suggested options included the shortened dental arch concept (SDA), the integration of precision-attachments as well as using implant-supported dentures, cantilevered fixed partial dentures or the combination of orthodontic- prosthetic treatments.

Key words: Removable partial denture, free-end saddle, unilateral distal extension, Kennedy Class II.

I. Introduction

Numerous classification systems exist to group the different patterns of partial edentulism, yet the Kennedy classification remains the most widely used classification system. It was introduced in 1925 by Edward Kennedy (Miller, 1970; McGarry et al., 2002).

According to the glossary of prosthodontics, Kennedy Class II is defined as a unilateral edentulous area located posterior to the remaining natural teeth (Driscoll et al., 2017).

In Nysanova's study, which was conducted on 250 partially edentulous patients, he found that the most prevalent type of partial edentulism conforming to Kennedy's classification is class III, calculating for about 50% of the maxillary cases and 41.1% of the mandibular cases, followed by Class I which accounts for 25% of the maxillary cases and 30% of the mandibular cases. Then comes class II accounting for 17.9% of the maxillary cases and 24.3 % of the mandibular cases. The least prevalent type of partial edentulism is Class IV which accounts for 7.1% of the maxillary cases and 5.6% of the mandibular cases (Charyeva et al., 2012).

In 2016 another study, conducted on 400 partially edentulous patients, was made in Dow International Dental Hospital at the Department of Prosthodontics. Results were similar to the previous mentioned study, in which Class III presented the most widely spread partially edentulous state. This study added that Class II represented the second most prevalent pattern

followed by Class I, & Class IV as the least prevalent among partially edentulous patients (Choudhary et al., 2016). This result was similar to a former study made by Patel in 2014 (Yunus et al., 2014).

Although Class II is not the most prevalent among Kennedy classes, it constitutes a big percentage among partially edentulous patients, presenting many challenges that we are going to review.

II. Review of the current literature Problems of Kennedy Class II

Kennedy Class II is of the most difficult cases to restore. Its combined tooth-tissue support nature results in support problem. In addition to the unilateral nature which leads to difficulty with its bracing, stability as well as retention. Additionally, other potential problems are abutment teeth mobility as well as decreased masticatory efficiency.

The Support Problem

Support as defined by the glossary of prosthodontics is the opposition to forces applied towards the basal tissues or underlying structures (Driscoll et al., 2017).

When enduring occlusal forces, the abutment tooth shows little movement of about 0.1 mm only, whereas the compressibility of the mucosa may range between 0.4 and 4 mm with mean resilience of 1.3 mm. In other words, the mucosa allows free movement to the saddle almost 13 times more than that permitted by the tooth in its alveolus (M et al., 1983).

The size and shape of the ridge, as well as the thickness and density of the overlying fibrous connective tissue and mucosa, affect the support provided by these tissues (Scott & Maillou, 2003).

Costa, Silva and Oliveira concluded in their paper that forces are spread evenly between the support structures in case of long saddles, whereas the dentures with short saddles induced more tension on the residual ridge (Costa et al., 2009).

In 2016, Carr and Brown stated that the greatest movement possible is found in the tooth-tissue supported type prostheses, as functional load is divided between abutment teeth and the distal extension supporting tissues (Carr & Brown, 2016).

The Bracing and Stability Problem

Bracing is defined by glossary of prosthodontics as opposing the horizontal components of masticatory force. Whereas stability was defined as the steadiness & firmness of a complete or removable partial denture to overcome any induced movement by functional horizontal or rotational forces (Driscoll et al., 2017).

Horizontal forces are generated on the denture by occlusal contact during function as well as by the oral musculature that surrounds the denture, leading to denture displacement both antero-posteriorly and laterally. Unless these lateral forces are controlled, considerable damage will result to the periodontal tissues surrounding the abutment teeth as well as to the alveolar bone in the edentulous area (Davenport et al., 2001).

Considering stability of the prosthesis, the occlusal relationships need to be designed in a way aiding at elimination of any interferences with the natural teeth. Over-erupted, drifted, or tilted teeth should be considered before starting the treatment to prevent eccentric forces during lateral or protrusive excursive movements of the mandible causing destabilization of the prosthesis (Scott & Maillou, 2003).

The Retention Problem

As defined by the glossary of prosthodontics, retention is the capability of the dental prosthesis to resist the dislodgment forces along its path of insertion (Driscoll et al., 2017).

This problem is exaggerated in the case of distal extension base dentures. In order to overcome this problem, retentive components are designed in the removable partial denture close to the saddle for providing direct retention and others distant from the saddle providing indirect retention. This is in addition to the seating effect of the

muscles on the polished surface of the denture as well as the physical forces obtained through the denture base coverage. Retention problems are more pronounced with mandibular distal extension dentures than maxillary ones, due to less available denture bearing area (Scott & Maillou, 2003).

Dislodgement of removable partial denture can be caused by force, pulling adherent food away from the teeth. This force is influenced by co-factors such as patient's masticatory habits, occlusion, teeth anatomy. It also depends on food characteristics including size, shape as well as texture (Chen, 2009; Cabrera et al., 2011).

Abutment Teeth Mobility

Poor denture stability can lead to encroachment of the underlying tissues, injury to residual alveolar ridges or trauma to the periodontal support of abutment teeth. Further resorption of the residual ridge and added on mobility of the abutment teeth might follow as long-term effects (Jin et al., 2004).

In addition, rotational movements of the prostheses created by functional stresses around the most posterior rest seats, result in torquing action on the abutment teeth unless direct retainers are designed with stress-breaking action (Loney, 2011).

Decreased Masticatory Performance

Studies showed that the masticatory performance and bite force denture-wearers were only half or sixth those of dentate subjects. This is significantly influenced by the type of dentures used as well as the number and distribution of the remaining natural teeth (Carlsson, 1984; Garrett et al., 1994; Miyaura et al., 2000).

In a split-mouth study comparing masticatory function of the unilateral RPD side versus the other dentate side, results showed that the mean masticatory ability index (MAI) of the RPD replaced side (0.65 ± 0.50, mean ± SD) was considerably lower ($P < 0.001$) than that of the dentulous side (1.06 ± 0.64). Also, the mean maximum bite force (MBF) obtained from the RPD replaced side (220 ± 155 N) was considerably lower as well ($P < 0.001$) than that obtained from the dentulous side (450 ± 268 N). On the other hand, MAI and MBF of patients with maxillary RPDs showed no significant difference in comparison to those of patients with mandibular RPDs (Tumrasvin et al., 2005).

Prosthetic Options for Kennedy Class II

In an effort to overcome the above-mentioned challenges, different treatment modalities have been introduced in literature to enhance success.

Clasp-Retained RPD

Partial edentulism has been addressed in the past primarily with removable partial dentures and it is believed to continue as a treatment option in the future with more people aging with partial edentulism. (Carr & Brown, 2016)

Many standards and designs have been modified and set, in order to maximize the opportunity of providing successful prosthesis.

Enhancing Support

As the distance from the abutment teeth increases, the role of the underlying ridge tissues in providing support becomes progressively more significant (Carr & Brown, 2016).

For maximizing support, "Snowshoe" principle is followed which is based on distributing forces over large area thus decreasing the load per unit area, comparable to the snowshoe which is designed to spread the forces over the whole area of the shoe. Thus, the partial denture should cover the utmost area possible within physiologic limits to deliver the forces over a large area (Carr & Brown, 2016).

Therefore, proper impression technique should be used to record the different supporting tissues, aiming at recording the functional form of the supporting ridge rather than the anatomic form, in which the functional form represents the form of the residual ridge under loading. This technique will minimize rather than eliminate the tissue-ward movement of the distal extension base. It must be taken into consideration that there is a difference

between placed and displaced tissues in their physiologic reaction to the amount of movement. Displaced tissues tend to return to their anatomic form, therefore when they are inhibited by the partial denture to do this, inflammation occurs to the tissues followed by bone resorption. Whereas tissues which are minimally placed by impression procedures respond positively to the extra pressures exerted on them by the resultant denture bases specially if this pressure is discontinuous rather than continuous (Carr & Brown, 2016).

Although in partial dentures with distal extensions, support is primarily provided through the ridge, yet nearer to the abutment, more of the occlusal load is transferred to the abutment via the rest, thereby dividing the load between the abutment and the residual ridge (Carr & Brown, 2016).

A study in 2003 emphasized that there is lower risk of distal tipping of the abutment tooth when using mesial rests. It is believed that mesial placement of rests allows for even load distribution (Scott & Maillou, 2003; Kumar & Walmsley, 2011).

Carr and Brown stated that combining a clasp with a mesial rest will result in lower forces transmission to the abutment tooth due to the decrease in leverage forces resulting from fulcrum position alteration (Carr & Brown, 2016).

Enhancing Bracing and Stability

Bracing in relation to the teeth can be obtained via rigid portions of clasp arms or plates, whereas bracing in relation to the ridges is obtained by the use of major connectors and flanges (Davenport et al., 2001).

For providing stability in a unilateral removable distal extension partial denture, cross-arch tooth support on the opposite side is mandatory. This is termed as cross-arch stabilization (Scott & Maillou, 2003). It is defined in the glossary of prosthodontics as resisting dislodging or rotational forces resulting from the use of a removable partial denture design that uses natural teeth on the contra-lateral side of the edentulous space aiding in stabilization (Driscoll et al., 2017).

One of the functions of a major connector in removable partial dentures is providing cross-arch stabilization by joining one side of the arch to the bracing elements on the other side of the arch, thus dissipating the torquing forces. Whereas minor connectors act as bracing elements through their contact with guiding planes opposing the retentive arms (Loney, 2011).

Enhancing Retention

Retention of an RPD can be attained mechanically by means of clasps engaging undercuts on the tooth surface, in addition to utilizing the patient's muscular control acting through the polished surface of the denture and/or using the inherent physical forces arising from the mucosal coverage by the denture. All these factors are essential because retentive clasps tend to lose some of their efficiency with time. That is why, in the course of time, successful retention would rely more on physical forces and muscular control. Whatever the type of clasp used, a denture will be retained efficiently only as long as the force required to flex the clasps above the maximum convexity of the teeth, exceeds the force aiming at dislodging the denture (Davenport et al., 2000).

Retention in distal extension bases is achieved by two mechanisms namely direct and indirect retention. Besides clasps as the primary retainers, secondary retention is obtained through close contact between the minor connectors and the guiding planes in addition to the major connector contact with the underlying tissues. Mechanical retention is mainly gained by means of friction, through engaging a prepared concavity in the abutment tooth or through engagement of an undercut that lies cervical to the height of contour (Carr & Brown, 2016).

Two main clasp assemblies are used in distal extension cases, namely the RPI clasp (which is composed of a mesial rest, proximal plate and I-bar) as well as the combination clasp assembly. The RPI clasp may be contraindicated in cases with severe buccal or lingual inclinations, deep tissue undercut or a shallow buccal vestibule. The

alternative in such cases is the RPA clasp assembly, which is a modification of the RPI clasp replacing the I-bar with Akers clasp. The RPA is also favored in cases with favorable undercut situated in the cervical third of the tooth away from the distal extension area. The combination clasp is simply made of a wrought wire retentive clasp arm in combination with a cast reciprocal arm. The wrought wire clasp provides flexibility and adjustability, in addition to its esthetic advantage over the cast clasp due its smaller diameter with less metal display (Carr & Brown, 2016).

When a distal extension denture base is ejected from the basal seat, it is likely to rotate around a fulcrum line, which is a hypothetical line joining the occlusal rests on the most distally located abutments (Driscoll et al., 2017).To avoid this movement, at least one rest and minor connector should be situated as far as possible from the distal extension base, to provide the highest leverage advantage counter to dislodgement. These components are known as indirect retention components. The proximal plates near the edentulous areas also account for indirect retention. Since incisor teeth are not strong enough to provide indirect retention, it is always desirable to choose the nearest canine tooth or the mesio-occlusal surface of the first premolar, regardless of the fact that it is not far enough from the fulcrum line. Whenever achievable two indirect retainers are used to compensate for the compromise in distance (Carr & Brown, 2016).

Attachment-Retained RPD

It is a type of conventional removable partial denture as well, in which mechanical retention is provided primarily through attachment system. Attachments consist of two metal components, male and female part. One of them is linked to one end of the prosthesis, while the other part is set to a restoration of an abutment tooth forming part of the prosthesis. This device is applicable to connect any two sections of a fixed or a removable prosthesis, but it's most commonly used to connect a removable prosthesis to a fixed restoration. Attachments were introduced to conceal the retentive element of the removable prosthesis within the body of the abutment or the prosthesis. It also targeted replacing the clasp assembly, together with all its unsatisfactory properties related to impaired hygiene, tooth mobility, caries susceptibility and poor esthetics (Nakazawa & Amemori, 1970).

Many extra-coronal attachment types exist that can be used in cases of free end saddles, such as: Clix attachment, Sagix attachment, Ceka attachment, Vertex attachment, OT attachment and many more (Gupta et al., 2018).

Rotational Path RPD

As defined by the glossary of prosthodontics, a rotational path removable partial denture is a removable partial denture that integrates a curved or atypical path of insertion permitting one or more of the rigid components of the framework to engage an undercut area (Driscoll et al., 2017).

In 2008, Donovan reported a Kennedy Class II case in which a rotational path removable partial denture was used for aesthetic purposes. The patient had her upper left posterior teeth missing from the first premolar). She had Sjogren syndrome, and chronic sinus infection, which made considering sinus lifting and implant placement not possible. The patient's prime request was restoring the teeth for aesthetic purposes, especially on social occasions. Therefore, the primary consideration in the RPD design was figuring out a way to refrain from the unpleasant clasp assembly on the canine. After surveying the primary cast, a favorable undercut was found on the distobuccal aspect of the left canine. If this undercut could be engaged and the framework thereafter rotated into place in the maxillary right quadrant, a rotational path RPD could be gained. To achieve that, a definite cingulum was created with a bonded nano-hybrid resin composite material. Regular rest seats were prepared on the opposite side at the occlusal surfaces of the second premolar and first molar. The rest of the steps were completed. It was concluded that the use of rotational path RPD concept allowed a conservative, successful and esthetic treatment option for this specific Kennedy Class II case, ruling out the need for crown placement and subsequent maintenance

accompanying the use of precision attachments (Donovan, 2008).

Cantilevered Fixed Partial Denture

A cantilever fixed dental prosthesis is described as a fixed complete or partial denture, where the pontic is cantilevered and retention and support are gained from one or more abutments (Driscoll et al., 2017).

The cantilevered bridgework administers a way of extending a short dental arch by a maximum of one unit distally that would be unilaterally in case of Kennedy class II. The cost of this treatment option would be higher than the conventional removable partial denture, but it provides a mean survival rate of 15-20 years (Creugers et al., 1994; Kumar & Walmsley, 2011).

In a study by Budtz-Jorgensen and Isidor they examined in contrast the prosthetic, functional, and occlusal conditions in twenty-seven patients who received distal extension cantilever bridges versus twenty-six patients who received removable partial dentures (RPD) in the mandible opposing complete upper dentures in all subjects (Budtz-Jorgensen & Isidor, 1987). A balanced occlusion in the muscular contact position was observed in 90% of the patients in the bridge group whereas it was obtained only in 76% of the RPD wearers. Also, during the course of the study, the need for dental or prosthetic treatment or maintenance was lower in the patients treated with bridges, in comparison to the RPD group, due to caries or subsequent mucosal irritations. Thus, the cantilever treatment modality could outweight the RPD modality, especially in geriatric patients with unilateral edentulous dentitions (Sharma et al., 2012).

Using Osseo-Integrated Dental Implants

The evolution of osseo-integration concept has introduced more fixed treatment alternatives when approaching the distal extension saddle cases `(Pjetursson et al., 2004).

As implied by a crossover study between patients restored with conventional RPDs in contrast to patients restored with implant supported RPDs, it was found that the implant supported RPDs treatment modality was favoured among patients due to its better retention, comfort, stability and chewing efficiency, resulting in high0er patient satisfaction (Ohkubo et al., 2008).

The main goal of placing an implant in the most posterior molar area in the distal extension base cases, is to provide stability of the RPD in vertical direction, in other words aiding in the support of the prosthesis. The distal implants here can convert Kennedy Class II into Kennedy Class III which is tooth-implant supported RPD. This is a cheaper option than a fixed total implant supported prosthesis (because fewer implants are needed) and at the same time it provides better option than the conventional removable partial denture (Turkyilmaz, 2009).

A recent study by Alkhodary in 2020, he concluded that the use of extra coronal attachment with a dental implant in Kennedy Class II cases, mainly locating the implant in the first molar region rather the second molar region, can aid in omitting the use of clasp and major connector in the RPD design. By placing the implant in the first molar position, the bounded span length is reduced. This will increase patients' satisfaction, as many patients complain of the major connector impairing their speech. Besides, the increased retention obtained by the extra coronal attachment minimizes the risk of accidental swallowing of the unilateral prosthesis (Alkhodary, 2020).

Orthodontic-Prosthetic Treatment Alternative

A multidisciplinary approach involving distalization of the most posterior abutment tooth, may be contemplated in rehabilitation of free end saddle cases. In a case report in 2006, a patient presented with unilateral free end saddle, missing the posterior molar teeth. The patient was offered two treatment options, either a conventional RPD or an implant supported fixed partial denture. The patient wasn't comfortable with either treatment options. An alternative treatment option was proposed, in which orthodontic treatment was used to distalize the second premolar tooth and move it to the first molar area. Then a conventional fixed prosthetic restoration was constructed. The advantage of this treatment option is that

vertically or horizontally atrophied edentulous ridge segments do not need surgical reconstruction, as reconstruction here is done by means of tooth movement. This spares the patient the need for more extensive preparatory surgery in case of implant treatment option, such as alveolar ridge augmentation or guided tissue regeneration (Arslan et al., 2006).

In an effort to overcome the challenges in Kennedy Class II, special techniques, and new modalities in RPDP treatment have been proposed to enhance its success. The choice of treatment is different in each case, all factors should be considered including age of the patient, medical and mental status, in addition to patient expectations.

III. Discussion & Conclusion

IV. References

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