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Removable Partial-Denture Construction in Patients with Diabetes Mellitus

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ABSTRACT

Prosthetic rehabilitation with denture treatment is aimed at stomatognathic system restoration. Diabetes Mellitus (DM) patients who require Removable Partial Denture (RPD) therapy are found in many dental and oral health centers. DM patients with complex oral manifestations need to receive serious attention by the dentist. Initially, the patient's examination should begin by knowing the history of the disease, so that it can help determine the appropriate measures for the patient and the diagnosis of the disorders that occur in the oral cavity. The main issue is the decline in quality and quantity of periodontal tissue. Therefore, determining the denture design should consider the kind of denture support as well as the appropriate denture base materials. The successful treatment is largely determined by the mastery of theory, laboratory and clinical skills, as well as good cooperation between the dentist and their patient.

KEYWORDS: diabetes mellitus, removable partial-denture design, denture base materials

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INTRODUCTION

In the case of partial tooth loss (partially edentulous), one alternative treatment to choose is the creation of Removable Partial Denture (RPD), since it is relatively easily manufactured and relatively cheap. Besides, the prosthesis is easily removed and reassembled.

RPD base has a variety of materials, namely acrylic resin; polyamide resin (thermoplastic nylon); metal frame, or a combination of metal frame and acrylic. It is also possible to combine metal frame and nylon. RPD construction should be done carefully, especially when diagnosing patients with DM.

DM is an endocrine disease characterized by the increase of glucose concentration in the blood circulation system. The increasing glucose concentrations are caused by relative or absolute insulin deficiency, or as a result of tissue resistance to insulin activity. Such insulin deficiency can cause disturbance in the metabolism of carbohydrate, lipid and protein.[1,2]

Patients with DM also experience oral tissue decline in quantity and quality, including the dental support and periodontium; as well as mucosa and alveolar bone structure underlying it, with oral manifestations including: gingivitis and periodontitis; apthose stomatitis; susceptibility to caries; burn mouth syndrome and candidiasis.[3] Therefore, the design of denture must be precise, especially by considering the correct selection of denture base materials, retention, stabilization, extension base, and biomechanical response. The design principle should consider the widest possibility of load distribution; the load equal division; as well as the load reduction on the RPD support tissue.[4]

Salivary flow decrease also occur in DM patients, which results in complaint on xerostomia. In addition, there is also a change in saliva composition caused by impaired secretion of submaxillary and parotid glands as a result of hormonal disorders. This can lead to stability disorders as well as denture retention. Thus, special care is required before and during prosthodontic treatment for DM patients.[5]

Based on the background mentioned above, this article will discuss a study of appropriate RPD construction techniques in cases of patients with DM.

Diabetes Mellitus (DM)

DM is a metabolic disorder in which the insulin hormone does not work properly. Insulin is a hormone produced by the pancreas gland that serves to control blood sugar levels by converting carbohydrates, fats and proteins into energy. DM is a chronic disease characterized by blood glucose levels exceeding the normal value of ≥ 200 mg / dl, or fasting blood ≥ 126 mg / dl. This may be due to a lack of formation or activation of insulin produced by β cells from

the Langerhans cells in pancreas or any damage to these cells.[6,7]

The classification of DM according to the American Diabetes Association is as follow.[8,9]

a. Type I DM
   In this diabetes type, the body cannot produce insulin, so it depends on insulin. It generally occurs in childhood and adolescence, but may also occur at older age due to alcohol, pancreatic surgery, or progressive failure of pancreatic β cells.
b. Type II DM
   It is known as Non-Insulin Dependent Diabetes Mellitus (NIDDM), which is caused by a combination of pancreatic β cell insufficiency and insulin resistance in tissues, especially in the skeletal muscle and hepatic cells.
c. Other type of DM
   This type includes genetic defects of β cell function, genetic defect of insulin action, pancreatic exocrine disease, endocrinopathy, due to drugs/chemicals, infection, rare immunological causes and other genetic syndromes associated with DM.
d. Gestational DM
   This type occurs in pregnant women whose symptoms subsequently disappear after childbirth. Women who suffer from this type of DM have a risk for the occurrence of Type II DM.

Oral Manifestation of DM[10,11]

Manifestations in oral cavity can be found in DM patients, such as gingivitis and periodontitis, dysfunction of salivary glands and xerostomia, candidiasis, burn mouth syndrome, and oral acute infection.

Gingivitis and periodontitis

Gingivitis is an inflammation of the gingiva that is easy to cure, where the gingival tissue looks reddish with swelling and easily bleeds when brushed. Gingivitis will lead to the formation of periodontal pocket with alveolar bone resorption, so the tooth is shaken and finally comes off.

Xerostomia and salivary glands dysfunction

Hyperglycemia results in the elevated amounts of urine, so that the fluid in body is reduced and salivary secretion is also reduced. The reduced saliva can cause xerostomia. In a healthy oral cavity, saliva contains antimicrobial enzymes, for example: lactoferrin, peroxidase, lysozyme and histidine that interact with oral mucosa and can prevent excessive candida growth. In situations where there are changes in the oral cavity caused by decreased salivary flow, so that the antimicrobial enzymes in the saliva do not function properly, then the oral cavity becomes susceptible to poor mucosal states which causes painful lesions. DM patients with salivary gland dysfunction may also have difficulty in chewing and swallowing resulting in appetite decrease and malnutrition.

Candidiasis infection

Oral candidiasis is an opportunistic bacterial infection occurring in a hyperglycemic state. It can lead to salivary dysfunction due to a large amount of fluid loss from the body, and reduce salivary flow. In addition, it also causes complications in the form of microangiopathy that most often appear in patients with controlled or uncontrolled DM. Therefore, candidiasis is often found in patients with DM and along with various factors, such as immune deficiency, saliva flow decrease, malnutrition and the use of denture with poor oral hygiene.

Burn mouth syndrome

Burn mouth syndrome usually appears without clinical signs, although the pain and burning are very strong. In uncontrolled DM patient, factors that cause the occurrence of burn mouth syndrome are salivary glands dysfunction, candidiasis and abnormalities in the nerve. The nerve disorder will support the symptoms of paresthesia and tingling, and pain/burning feeling caused by pathological changes in oral nerves.

Periodontal damage

If DM is not controlled well, it can cause damage to the body in general or in the oral cavity. The increase of periodontal destruction in DM patients is reflected through the loss of bone attachment, the increase of gingival pocket depth, the increase of gingival inflammation, and the presence of probing bleeding. Starting from a declining body endurance system, DM causes the collagen fibers as the main support of periodontal tissue to collapse that affects the shaking of teeth due to the loss of contact with alveolar processus. However, the severity of periodontal disease can be reduced if DM is under appropriate control.

Dental caries

DM may be a predisposing factor for an increase in the incidence and number of caries. This condition is thought to be due to the high quantity of glucose in blood circulation and saliva that acts as a cariogenic substrate.

RPD Design

RPD is a prosthesis that replaces some or part of the original tooth that is lost in the arch of the jaw. This prosthesis can be installed and removed by the patient himself. Its main function is to restore mastication, along with other functions such as phonetic, esthetic and maintaining oral tissue health.

Owal B. et al[12] stated that if a person with partial tooth loss is not immediately replaced with RPD, it will have an impact on tissue damage such as: the remaining teeth undergoing drifting, tilting and migration; over eruption; chewing efficiency decreased; temporo-mandibular disorder; excessive pressure on the buffer tissue; change in voice tone; as well as declining oral hygiene.

The RPD design is the most important and it is also the critical factor for success or failure. It includes 4 (four) sequential stages, namely: 1) Determining the classification

or topography of the toothless areas; 2) Determining the kind of support (the tissue that will support denture); 3) Retention; and 4) Stabilization.

The commonly used classification is Kennedy, which categorizes partial tooth loss cases based on the toothless area location. Kennedy divides it into four classes: I. Bilateral free end; II. Unilateral free end; III. Unilateral bounded posterior; and IV. Anterior bounded. [13]

There are three choices of denture support tissues, namely the support from the teeth and the periodontium (tooth borne), the support from the mucosa and the underlying tissue bone (tissue borne), or the support from the combination of the two (tooth-tissue borne). The best support for removable partial prosthesis can be obtained by considering several factors, namely: the buffer tissue condition, the length of the saddle, and the condition of the network occupied by the denture.[13]

Retention is the ability of denture to stand in place against pressure from the opposite direction of the path of insertion. Good retention can be achieved by selecting the potential buffer teeth that will be occupied by clasp retainer and selecting the appropriate clasp for each case. The retention assessment is performed when the denture is in a static state.

Stabilization is the denture ability to survive on the supporting tissue against any pressure that can change its position. The factors to be considered are the direction of fulcrum line, the clasp direction, and the artificial teeth arrangement. The stabilization assessment is performed when the prosthesis is in a function / dynamic state.

Denture Base Materials

The basic materials for the removable denture base should ideally meet some criteria: non-toxic; not irritating and not affected by the oral environment (so that it does not dissolve or absorbs mouth fluid), has a thermal expansion corresponding to the dental material; has sufficient mechanical strength, does not change in shape at the time of manufacture and use; easy to be manufactured with affordable cost; easy to manipulate; easy to clean; as well as having color according to the surrounding tissue color.

Generally the element of artificial teeth is made of acrylic resin, while the base material is available in the laboratory in many choices, namely: acrylic resin, nylon resin and alloy.

Acrylic resin is an ethylene derivative that has vinyl group. Compared to other materials, acrylic RPD base is the most economical. The plates are relatively thicker and there is also wrought wire clasp as retainer placed on the abutment tooth. The advantages of this base material are good appearance, easy manufacturing, good finishing surface, and excellent chemical bond. However, in addition to the advantages, this material also has some drawbacks, namely the presence of residual monomers, the unreliable strength and poor flexibility, and absorbing water and dissolving in some fluids.[14]

Nylon is a generic name of polyamide resin. This material is more flexible than other denture base materials. Its flexible nature supports the denture flexibility. The denture retention is obtained by utilizing the undercut area. Nylon is monomer free, does not use metal clasp, and is more flexible and thinner than acrylic denture, so it will feel more comfortable for patients.[15,16]

RPD base with alloy material is also known as metal frame denture. The most commonly used alloy materials are NiCr and CoCr alloys. Alloy material is stronger than other base materials, so it can be made thinner and practical but still rigid; more retentive and stable than other denture base materials. It is also a good thermal conductor and has good dimensional stability. The disadvantage is only the aesthetic problem that is less satisfactory for patients and difficult to be repaired if damaged.[17]

GTSL Construction on Diabetic Patients

The successful GTSL treatment depends on the diagnosis and the appropriate treatment plan and good cooperation between the dentist and the patient. The maintenance of GTSL support tissues such as restorative procedures, root canal treatment and tartar cleaning should be completed first. Good oral hygiene and proper design determination should also be noted.[18,19,20]

Typically, diabetics have problems with periodontal tissue. Therefore, all GTSL components must be compatible with their supporting tissues. The design principle should consider the distribution of loads received by the denture as large as possible, so that the load received by the denture will be evenly channeled throughout the supporting tissues. Equal load distribution should also be taken into account, i.e. the loads received by the buffer gear and the periodontium and the load received by the underlying mucosa and bone alveolar. Load reduction can be done by minimizing the tooth element in the bucco-lingual/palatal direction.[21,22,23]

Fungal infections, stomatitis and dry mouth are common oral manifestations in DM patients. Therefore, RPD design should also consider the selection of appropriate materials and denture construction with a primary focus on stress reduction and efficiency of self cleansing and extra attention from patients to keep their oral hygiene. Acrylic resin denture base is preferably avoided, because in addition to its rigid nature, it has a monomethyl methacrylate monomer residue which can trigger hypersensitivity reactions as well as a dimethyl activator ingredient of toluidine that can induce free radicals. If economic factor becomes the biggest consideration, then it is recommended that acrylic material is combined with tissue conditioner material placed under the base and contacted directly with the surface of the denture supporting tissues. The tissue conditioner has a role as a stress breaker in the chewing load, so that the load received by the denture support tissue is reduced. Similarly, metal frame denture is also a contra indication, with consideration of its rigidity and easily corrodible metal. DM patients have high glucose concentration in saliva and low salivary pH.

Corrodible products in the form of metal cations can aggravate the condition of DM patients, which can increase oxidative stress and cell death.

Neutral zone concept needs to be applied with attention to anatomical landmarks. This concept can be done by functional printing to achieve replicas depicting the tissues that are truly ready to receive denture. The neutral zone principle in RPD construction is to maintain a balance among the muscles of the stomatognathic system.

DISCUSSION

Periodontitis is inflammation of the tooth supporting tissues (gums and bones). In addition to damaging white blood cells, another complication of diabetes is the thickening of blood vessels that slows down the flow of nutrients and metabolite products from the body. This slow flow of blood decreases the body's ability to fight infections. Meanwhile, periodontitis is a disease caused by a bacterial infection. This becomes more severe as bacterial infection in patients with diabetes gets worse.

The association between DM and denture has been known, and both tend to increase the incidence of oral candidiasis. Fungal proliferation can be induced by the presence of denture in the mouth, especially in the palatinal mucosa. Compressed tissue by artificial teeth will cause the decline in local blood circulation. This can be worsened by the poor oral hygiene. Poor attention to oral hygiene can also trigger proliferative lesions such as lichen planus, leukoplakia or erythroplakia.[24,25]

Hypo salivation may cause Candida albicans and other species proliferations, and also may trigger other oral infections. Increasing glucose concentration can facilitate the attachment of fungi to epithelial cells and interfere neutrophyl polymorphic defense mechanisms. The manifestations of oral candidiasis can occur in various forms such as median rhomboid glossitis, athrophic glossitis, denture stomatitis and angular cheilitis.[25]

Jorgensen et al[26] stated that flexible denture provides a dramatic increase in mastication, comfort and satisfaction. The flexible denture supporting tissue is healthier with fewer tissue changes than conventional denture. The above restorations are best for DM patients, with the consideration that their flexibility can minimize the stress on the denture supporting tissues. The disadvantage is that the presence of clasp resin covering the cervix at the marginal region of the gingiva may cause changes in the character of the periodontium and less hygienic structures.

In general, diabetic patients who use artificial teeth complain about the changes in taste sensation and other neurosensoric disorders such as burn mouth syndrome and disphagia. The causes of such complex symptoms are the variations in salivary flow, salivary changes in buffer capacity and peripheral neuropathy. The presence of retinopathy and neuropathy severely restricts the hand of the patient in oral hygiene maintenance of the denture.[27]

Oral mucous membrane loses its resilience because xerostomia indirectly affects the denture retention. Soft tissue resistance is an important factor for good adaptation of the prosthesis.[28]

Periodontitis is more common and severe in diabetic patients than in normal people. The functions of the cells involved in this inflammatory response, including neutrophils, monosites and macrophages, are altered in people with diabetes. Compliance, chemotaxis and neutrophil phagocytosis are often impaired. These cells are the leading line of host defense, and inhibition of their function can increase periodontal damage. Other immune-inflammatory responses are regulated in people with diabetes. For example, macrophages and monosites often show the production of pro-inflammatory cytokines and mediators such as tumor necrosis factor-α (TNF-α) in response to periodontal pathogens, which can increase host tissue damage. High TNF-α levels are found in blood and gingival fluid sulcus. It is correlated with the increasing cell death, so that glycemic control may be an important factor of this response.[29]

Periodontal conditions are closely related to the quality of the denture support. DM patients generally have poor periodontal health conditions, characterized by the decrease in blood supply to the tissues due to microvascular angiopathy. This affects the residual alveolar ridge resorption. Therefore, the denture construction should consider the widest possible load distribution, share the burden equally among its supporting tissues, and reduce the load.

McGivney et al[30] stated that for GTSL design should consider the biomechanical principle, which focuses on the distribution of load, retention and stabilization. Meanwhile, Dula LJ[31] suggested that hygienic design principles should be applied, by controlling dental plaque. The goal is to prevent caries and periodontal diseases. This principle is done by freeing the marginal of gingiva from attribute of denture.

The ideal GTSL design should minimize stress on the supporting tissues (dental and alveolar bone); it should be as simple as possible, involving only the essential soft and hard tissues and taking into account the hygienic principles; and it should also use a retainer in the form of a clutch, because clutch causes a smaller torque compared to attachment.[32,33,34]

Chewing force and its effects on the supporting gear and surrounding tissue need to be considered when designing and constructing GTSL. Adequate planning requires an understanding of the power generated during mastication and its distribution to the supporting tissues. If these principles are followed when designing and constructing the prosthesis, the resulting stress can be tolerated by the tissues, so that periodontal health is maintained.[35,36,37,38]

GTSL with distal extensions (in free-end denture cases) has no advantages, compared to dental support, since residual ridges should be used for support and retention. Biomechanically, the distal extension has a tendency for

lateral movement during function and can also cause leverage.

Diabetic patients are more susceptible to infection and severe damage from the mouth tissue. Therefore, the dentist is obliged to fully educate and motivate the patients on the importance of maintaining good oral hygiene and making periodic visits to the dentist. This will ensure the long-term health of the oral tissues by preventing chronic infections such as denture stomatitis and denture hyperplasia that can lead to more serious conditions.

In patients who wear denture, problems in the tolerance of the dentures will arise. Dry mucosa causes the uncomfortable use of denture, due to the lack of salivary secretions that may contribute to the adhesion of the denture. In addition, there is a decrease in surface tension between the dry mucosa and the denture, which results in disruption of denture retention and stabilization.

DM can cause predisposing factor disorders in the patient's mouth. If it is not carefully controlled it can cause serious bodily harms. Prosthodontic treatment, especially the preparation of RPD, is intended to restore the stomatognathic system. Therefore, the dentist should alert the DM patient before undergoing further treatment. In addition, the examination should be preceded by a history of the disease first, so it can help to determine the appropriate actions for patients and the process of diagnosis of disorders and disorders that occur in the oral cavity.

CONCLUSION

Diabetes Mellitus is a complex disorder that has many problems in the oral and systemic cavities. A multi-disciplinary approach is essential for the successful management of diabetes mellitus. RPD construction can be done after completion of a complete patient evaluation through the patient's medical history, examination and diagnostic model creation. Before starting the prosthesis-making procedure, the OH of diabetic patients should be evaluated and should be improved through periodontal therapy and conservative care, in order to support adequate supporting tissue quality. The success of RPD treatment is strongly determined by the mastery of theory and good cooperation between dentists and patients.

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