

Introduction

Loss of posterior teeth may result in the losing the neuromuscular stability of the mandible, reduced masticatory efficiency, loss of vertical dimension of occlusion and poor aesthetics. Prosthetic rehabilitation should aim at restoring the vertical dimension and increasing the occlusal contact area in the premolar/molar region. Overdentures are indicated in patients with a severe loss of periodontal attachment, impaired periodontal condition and complicated functional or aesthetic conditions. This is mandatory in order to obtain a satisfactory prognosis. In a patient with poor oral hygiene, the best solution, with regard to the prognosis of the remaining teeth is to avoid any prosthetic treatment (Budtz-Jorgensen, 1996).

Telescopic denture is considered a type of overdenture, which is defined as any removable dental prosthesis that covers and rests on one or more of the remaining natural teeth, on the roots of the natural teeth, and/or on the dental implants. It is also called as overlay denture, overlay prosthesis and superimposed prosthesis (Singh & Gupta 2012). The telescopic denture supported

by the natural teeth gained significant popularity as an alternative to the conventional dentures during the 1970s and the 1980s. The retained teeth that support the overdentures, preserve the bone and they minimize the downward and forward settling of a denture, which otherwise occurs with alveolar bone resorption (Singh and Gupta ,2012).

Telescopic denture is a prosthesis which consists of a primary coping which is cemented to the abutments in a patient's mouth and a secondary coping which is attached to the prosthesis and which fits on the primary coping. It thereby increases the retention and stability of the prosthesis. They transfer forces along the long axis of the abutment teeth and provide guidance, support and protection from the movements that dislodge the denture (Langer Y and Langer A., 1991).

The introduction of new material in dentistry serves the great demand of esthetic among population Zirconia (ZrO_2) is a ceramic material with adequate mechanical properties for manufacturing of medical devices. Zirconia stabilized with Yttrium oxide has the best properties for these applications. When a stress occurs on a ZrO_2 surface, a crystalline modification opposes the propagation of cracks. Compression

resistance of ZrO₂ is about 2000 MPa (Manicone, Iommetti & Raffaelli, 2007).

Poly-ether-ether-ketone (PEEK) has been successfully used over the last years in the medical field, specifically in orthopedics. High performance polymer BioHPP is a modified PEEK material containing 20% ceramic fillers, which is highly biocompatible, has good mechanical properties, high temperature resistance and chemically stable (Zoidis P., 2015). Due to a 4 GPa modulus of elasticity, which is like elasticity of bone, it can reduce stresses transferred to the abutment teeth. Furthermore, different esthetic approach can be provided because of the white color of BioHPP framework when compared with the conventional metal framework (Zoidis P., 2015).

Computer-aided design/ computer-aided manufacturing (CAD/CAM) technology has gain popularity in implant dentistry (Papaspnyridakos & Lal, 2008). The applications pertain to 3-dimensional (3-D) imaging (computerized tomography scan), 3-D software for treatment planning, fabrication of computer-generated surgical guides using additive rapid prototyping, as well as fabrication of all-ceramic restorations using subtractive rapid prototyping (Papaspnyridakos & Lal, 2008).It has been shown that

industrial manufacturing of CAD/CAM (Computer Aided Design/Computer Aided Manufacturing) blanks for composite and PMMA based reconstructions significantly improves mechanical properties (Stawarczyk et al., 2014).

Although numerous in vitro studies were conducted to assess stresses induced in different forms of tooth support mandibular overdentures, there is rareness of information about stress induced on tooth supported telescopic overdenture using Zirconia and BioHPP.

Review of literature

1. Overdentures:(OD) are defined as a removable prosthesis that covers the occlusal surface of root or prepared tooth or an implant. Various terms have been used to describe this treatment modality: overlay denture, telescoped dentures, tooth supported dentures, hybrid prosthesis, crown and sleeve prosthesis, and the superimposing dentures. The concept of overdentures has arisen a century ago. Henking stated that Ledger and Atkinson advocated leaving 'Stumps' under artificial dentures for support.(Henking 1982)

Surveys in most of the civilized world have shown that the percentages of those over 65 years of age are increasing and statistics indicate that this trend will continue to further decades(Preiskel H 1996).

ODs can be used as a treatment modality either in the form of complete or partial overdenture. As a treatment option, they carry numerous advantages for potentially edentulous patients over conventional dentures in terms of preservation of the remaining alveolar supporting-bone along with increased stability. The presence of a healthy periodontal ligament maintains alveolar ridge morphology, whereas a diseased periodontal ligament or its absence, might be associated with variable but unavoidable time-dependent reduction in residual ridge dimensions (Burns 2000). Crum and Rooney in a five year study of patients wearing overdentures and conventional dentures reported that the vertical alveolar bone loss in the anterior region under complete

mandibular overdentures supported by canine abutments and opposed by complete conventional dentures was only 0.6 mm after 5 years. In the case of conventional lower dentures, the loss averaged 5.2 mm (Crum and Rooney Jr. 1978).

To avoid this, two or more coronally prepared or restored teeth abutments are frequently endodontically prepared and used as abutments for an overdenture. The objective is to distribute stress concentration between retained abutments and denture-supporting soft tissues. Mullar Devan (1952) golden statement, “Perpetual preservation of what remains is more important than the meticulous replacement of what is missing” still rings true. Overdentures are one of the most practical measures used in preventive dentistry and as a better option in comparison with removable complete denture prosthesis in many ways (Devan 1952). Overdenture is indicated in patients with few remaining retainable teeth in an arch. It is also preferred in patients with unfavorably related ridge cases, patients needing single denture, patients with unfavorable tongue positions, muscle attachments, or high palatal vault, which render the stability and retention of the prosthesis difficult (Zarb, Eckert, Jacob 2013).

Advantages: When comparing masticatory performance in patients with natural dentition, complete denture and overdenture. It was deducted that the over-denture patients had masticatory efficiency one-third higher than the complete-denture patients(Rissin et al.1978). In case of over-denture prosthesis, proprioception is maintained. The presence of dimensional

discrimination; canine response and tactile sensitivity is preserved (Manly et al. 1952). The average threshold of sensitivity to a load was found to be 10 times as great in denture wearers as in dentulous patients (Thayer HH 1980). Posselt stated that the motor performance was programmed and monitored by the sensory feedback from oral receptors. The periodontal proprioception was mainly responsible for precise closure into the intercuspal position (Posselt U 1968).

Crum and Loisel reviewed subject of oral perception and proprioception and concluded that periodontal receptors had an important role in the overall neurologic mechanisms controlling and monitoring the jaw function (Crum and Loisel 1972). Dodge believed that the periodontal sense under overdentures helped skillful manipulation of the appliance and precision in jaw movements (Dodge 1973). Renner et al stated that the retained roots of anterior teeth under the overdenture helped prevent the sequelae of anterior hyperfunction syndrome, an all too common problem associated with conventional complete dentures (Renner et al. 1984). Numerous techniques used in the treatment of teeth to serve as abutment for over-denture ranges from simple tooth modification and reduction, tooth preparation with cast-coping to endodontic therapy with amalgam plug or cast-coping using some form of attachments. (Vivek R et al., 2016).

Root canal treatment is a necessary phase of preparation for the selected teeth; single-rooted, double-rooted and triple-rooted teeth with accessible canals are preferred. Teeth that are mobile as a result of bone loss can become acceptable for overdenture

support when the clinical crown is prepared to near ridge height. The aim in using tooth supported over-denture is to preserve the remaining supporting tissue and to restore missing structures in order to provide maximum service for maximum amount of time. A major premise of tooth supported overdenture treatment is to transfer occlusal forces along the long axis of the tooth, to minimize the horizontal torque and lateral forces to allow for a more optimum situation for periodontal ligaments (Warren AB 1975) .

1.1 Retention systems in overdentures: Different types of attachments have been described in literature each has advantages and disadvantages, However specially shaped cast copings alone have been described as effective.

Gerber attachments is a stud type of unit consisting of male and female sections, and it is available in resilient (containing a replaceable spring) and non-resilient designs. Advantages of such attachment are: the resiliency that provides a degree of “give” which may be compatible with tissue displacement under the denture base. Also both male and female sections of the attachment can be replaced by simply unscrewing the worn unit and screwing in a new one. In addition to it provides excellent support, stability, and retention. The disadvantages are that they require considerable space or height and therefore difficult to use where there is a short interocclusal distance. It is relatively complicated to place because it must be positioned with a paralleling instrument or surveyor on a cast. A precision pickup impression of the copings in the mouth is required and the female

unit must be laboratory processed to the denture. It is relatively expensive due to the precision procedures and the original cost of the attachments. Cleaning of the female part of the attachment may present a problem (Dodge 1973).

Rothermann attachment: consists of a short stud with a retaining groove. Retention is provided by a c-shaped ring or clip designed so that the free ends of the clip engages the deepest portion of the retaining groove. The stud comes with a central core of solder for easy attachment to the coping. It possess the advantage of being shorter than Gerber attachment thus more convenient in limited inter occlusal space. Strict parallelism is not essential making them more technique friendly; finally the female clip can be attached to the denture base by cold cure resin pick up or as a laboratory procedure. On the other hand the disadvantages of such type are; too bulky for many situations and generally has to be used in conjunction with a plastic overtooth, frequent adjustments may be necessary and are difficult to perform, Also breakage has been reported as problem(Manly et al. 1952).

Baker Clip Attachment: consists of a small U shaped clip designed to snap over a piece of round wire. It is available in 12 or 14 gauges. Retentive means should be added to the clip to secure it in the denture. It is small and can be positioned lingually on the coping giving more room for setting of teeth, simple design and parallelism is not mandatory(Preiskel H 1996).

1.2 Requirements of telescopic attachment: Careful assessment of the interarch space is important for the success of the telescopic dentures. Sufficient space must be present to accommodate the primary and secondary copings, to have a sufficient denture base thickness to avoid fracture, space for the arrangement of the teeth to fulfill the aesthetic requirements and to have an interocclusal space. The space consideration usually requires the devitalization of the abutments. (Preiskel H 1996).

The selected abutments should be periodontally sound with adequate bone support and no/ minimal mobility. There should be at least one healthy abutment in each quadrant. An even distribution of the abutment in each quadrant of the arch is preferable for better stress distribution and for increased retention and stability of the prosthesis. The interarch space should be ≥ 10 mm, in order to have sufficient space for the copings, denture base, teeth placement and adequate closest speaking space.

A telescopic denture is a prosthesis which consists of a primary coping which is cemented to the abutments in a patient's mouth and a secondary coping which is attached to the prosthesis and which fits on the primary coping. It thereby increases the retention and stability of the prosthesis (Singh and Gupta 2012). Support and frictional retention for the prosthesis is provided either by secondary cast copings fitting over the primary copings and incorporated as an integral part of the denture base or by processing the dentures base resin directly over the primary copings cemented onto the abutments. Telescopic crowns were initially introduced as retainers for the removable partial dentures

at the beginning of the 20th century. They were also known as a Double crown, a crown and sleeve coping or as Konuskrona a German term that described a cone shaped design. These crowns are an effective means for retaining dentures. They transfer forces along the long axis of the abutment teeth and provide guidance, support and protection from the movements that dislodge the denture.(Langer Y, Langer A., 1991).

The double crown systems are usually distinguished from each other by their difference in retention mechanism. There are three different types of double crown systems. These are; telescopic crowns which-achieve retention by using friction and conical crowns or tapered telescope crowns which exhibit friction only when they are completely seated by using wedging effect. The magnitude of the wedging effect is mainly determined by the convergence angle of the inner crown; the smaller the convergence angle, the greater is the retentive force. The third type is double crown with a clearance fit also referred to as a hybrid telescope or a hybrid double crown exhibits no friction or wedging during its insertion or removal. The retention is achieved by using additional attachments or functional molded denture borders(Singh and Gupta 2012).

The retention and the stability of the telescopic denture are directly related to the number and the distribution of the abutments along the dental arch and the taper of the wall of the primary coping. The tapered configuration of the contacting walls generates a compressive interfacial surface tension. The tension should be strong enough to sustain the prosthesis in its place. An

increase in the tapering of the coping walls reduces the retention between the copings. The smaller the degree of the taper, the greater is the frictional retention of the retainer. In case of the abutments with short clinical height, the walls should be kept parallel or the taper of the wall should be reduced (2-5°) to improve the retention. The taper of walls of the primary coping can be adjusted to a predetermined angle according to the special requirements of each patient (Singh and Gupta 2012).

The contours and the degree of taper of the outer aspect of the primary coping determine the path of insertion and the amount of retention of the prosthesis. The retention varies inversely with the taper of the coping. Even copings of minimal taper approximately 5 degrees require a height of about 4mm to achieve a significant retention (Zafiropoulos et al. 2010).

The height and size of the inner coping also dictates the retention. The essential requirements for the long service of the telescopic prosthesis are to provide adequate height of the vertical walls (at least 4mm), sufficient thickness of the copings never less than 0.7mm for each casting and a taper of around 6° (Bergman, Bo., Ericson, Ake, Molin 1996).

1.3. Different materials involved in manufacture of telescopic crown: Miller revived interest in the telescopic overdentures. He advocated primary gold copings over reduced abutment teeth and secondary individual gold copings under the denture base (Miller 1965). Yalisove described crown and sleeve coping retainers for overdentures. The telescopic units consisted

of long dome-shaped primary gold copings over multiple abutments and a set of secondary cast copings attached to the overdenture. The secondary copings had a milled-in relief to serve for stress reduction (Yalisove 1966). Lord and Teel advocated fairly short rounded primary copings and no metal inserts for the overdenture (Lord and Teel 1974). Brewer and Fenton advocated short dome-shaped reduction of endodontically treated abutments followed by amalgam fillings and construction of overdentures with no castings (Brewer AA 1973). In a two year study of overdenture patients Toolson and Smith reported high caries susceptibility of uncovered abutment teeth which was significantly reduced by flouride applications (Toolson and Smith 1978).

2.Zirconia:

Zirconia or zirconium dioxide (ZrO_2) is a highly attractive ceramic material in prosthodontics due to its distinguished mechanical properties related to transformation toughening, which are the highest ever reported for any dental ceramic and enhanced natural appearance compared to metal-ceramics (Kelly and Denry 2008)(Garvie 1965). It is widely used to build prosthetic restoration due to its good chemical properties, dimensional stability, high mechanical strength, toughness and a Young's modulus (210 GPa) similar to that of stainless steel alloy (193 GPa).

The high initial strength and fracture toughness of zirconia results from a physical property of partially stabilized zirconia

known as transformation toughening (Piconi and Maccauro 1999)(Garvie 1965). Zirconia is a polymorphic material that has 3 crystal phases: monoclinic (m), tetragonal (t), and cubic (c). At room temperature, zirconia is in monoclinic phase and transforms into tetragonal phase at 1170°C, followed by a cubic structure at 2370°C (Piconi and Maccauro 1999). While cooling the metastable tetragonal zirconia is transformed into stable monoclinic zirconia. The tetragonal to monoclinic phase transformation is associated with a large volume expansion (3-5%) that induces compressive stresses opposing crack opening and acts to increase resistance to crack propagation (Garvie 1965). In vitro studies of zirconia specimens demonstrate a flexural strength of 900 to 1200 MPa and a fracture toughness of 9 to 10 MPa/m² (Christel et al. 1989). It is a bioinert non soluble metal oxide that also exhibits favorable radio opacity and a low corrosion potential (Akagawa et al. 1993).

Zirconia frameworks can be produced according to two different CAD/CAM techniques. In soft machining technique, CAD/CAM systems shape pre-sintered blocks, which involves machining enlarged frameworks in a so-called green state. The enlarged pre-sintered zirconia frameworks are then sintered in a sintering furnace to their full strength that is accompanied by shrinkage of the milled framework by 25% to the desired dimensions. In hard machining technique, fully sintered blocks are shaped (Kelly and Denry 2008). The framework coloration is performed either adding metal oxides to the zirconia powder, or embedding the frameworks in metal salt solutions after machining

(Zarone, Russo and Sorrentino 2011). Glazing is created by firing a small coating of transparent glass onto the surface or by heating the framework up to glazing temperatures for 1 to 2 minutes to get shiny glass surfaces (Kim HK, Kim SH, Lee JB, Han JS 2013).

Although zirconia has superior mechanical properties, its opaque white color and insufficient translucency require glassy porcelain veneering on the framework to achieve a natural appearance and acceptable esthetics (Miyazaki et al. 2013). However, cracking or chipping of the porcelain veneer has been reported to be a major complication of these restorations (Sailer et al. 2007). The possible causes of porcelain veneer cracking are; differences in coefficient of thermal expansion (CTE) between framework and porcelain, firing shrinkage of porcelain, porosities, poor wetting of veneering, flaws on veneering, inadequate framework design to support veneer porcelain, overloading and fatigue (Miyazaki et al. 2013).

There are several solutions to overcome the veneer cracking problem due to its multifactorial nature: alternative application of techniques for veneering such as CAD/CAM produced veneer (Schmitter, Mueller, and Rues 2013), modification of the firing procedures (Rues et al. 2010), and modification of the framework design (Rosentritt et al. 2009). Another alternative solution was to use non-veneered zirconia restorations. The translucency of zirconia was increased and full-contoured, monolithic zirconia restorations without veneering porcelain have become increasingly popular as a result of advances in CAD/CAM