The Windowed Removable Partial Denture: A Treatment Option for Patients with Lone-Standing Teeth

ABSTRACT:

The decision as to whether to retain or extract a single remaining natural tooth prior to the provision of dentures can be a difficult one. If the tooth is left in situ, the development of an adequate peripheral seal around the denture is not possible thereby compromising the appliance' retention. If the tooth is extracted the possibility of gaining direct retention with the use of clasps or attachments is lost. This paper aims to illustrate the use of windowed removable partial denture design and review the literature relevant to this area. The use of such a design can enhance the retention of the appliance by encircling the lone standing tooth/teeth utilising an elastomeric permanent soft lining material.

Keywords

Denture
Retention
Lone standing teeth
Permanent soft liner

Authors

Ahmad A. Jum'ah
(BDS (Hons), MSc (Clin) Rest Den)

Terence Haite
(BTEC Senior dental technician)

Brian Nattress
(BChD, PhD, MRD, FDSRCS (Edin))

Address for Correspondence

Ahmad A. Jum'ah

Department of Restorative Dentistry,
School of Dentistry,
University of Leeds,
LS2 9LU,
UK

Email: dnaahj@leeds.ac.uk

INTRODUCTION

Despite evidence of improvements in oral health a significant number of patients require the provision of either partial or complete dentures[1]. Achieving patient satisfaction with removable prostheses is often perceived as a significant challenge by many clinicians. It is well established that patients' satisfaction is affected by several interrelated factors such as; the technical quality of the removable prosthesis[2], patient related factors and psychological dynamics[3], dentist-patient communication and the patient's denture-wearing experience[4].

Retention, stability, support, occlusion and aesthetics are criteria against which the quality of a removable prosthesis can be assessed. Retention is defined as the ability to resist forces applied to the occlusal, polished and impression surface of the denture that cause the prosthesis to be dislodged in the direction of the path of insertion. Removable partial dentures rely heavily on active retention. Flexible termini of clasp assemblies actively engage undercuts around teeth. Rigid framework components that gain access to undercuts around teeth or the residual ridge through a rotational path of insertion also contribute toward retention. Frictional forces between minor/major connectors and opposing parallel surfaces of teeth play a complementary role.

With regard to complete dentures, retentive forces can be divided into muscular and physical forces. Forces generated by muscle movement during function cause seating rather than dislodgment if the prosthesis is adequately extended and contoured in relation to anatomical limiting structures. In addition, muscular control of the prosthesis is an acquired skill that patients develop over the time. Physical retentive forces depend on the thin film of saliva intervening between the denture's fitting surface

doi: 10.1922/EJPRD_1399Jum'ah06

and denture bearing area. Physical forces can be magnified by ensuring accurate fit, coverage of maximum surface area and more importantly, attaining a good peripheral seal[5].

To achieve an optimum peripheral seal, the denture should be extended to the maximum functional depth and width of the facial and lingual sulci. This in turn, maintains negative pressure and surface tension that retains the prosthesis in place during function. In some clinical presentations, a peripheral seal is unattainable. The presence of lone-standing teeth is a common example on this.

The aim of this paper is to discuss the treatment options available for this clinical presentation and to illustrate the use of the WRPD design. A narrative review which includes treatment planning options is included to assist the clinician in the decision making process.

LONE-STANDING TEETH: TREATMENT OPTIONS

Several treatment approaches can be utilised to optimise retention of removable prostheses in situations where lone-standing teeth are present. The decision as to whether to retain or extract lone-standing remaining natural teeth prior to the provision of dentures can be a difficult one and should be made after a through history and clinical examination. Several factors should be considered including; the strategic importance and prognosis of the tooth, the occlusal relationship of the tooth, the patients' ability to maintain good plaque control around the tooth along with general factors relating to the patient's medical history[6,7].

Extraction

If a lone-standing tooth is left in situ, the development of an adequate peripheral seal around the denture is not possible thereby compromising the retention of the appliance. This is particularly relevant in the maxillary arch. Extraction of lone-standing teeth may facilitate the placement of the denture teeth in an optimal position in relation to both aesthetic and occlusal considerations. Conversely, it will eventually cause bone resorption which compromises the support provided to the denture and eliminates the possibility of providing active retention. It also removes the psychological advantage from patients of retaining their natural teeth.

Extraction of remaining teeth may be ill-advised in patients who are at risk of developing serious complications after dental extractions, e.g. patients with blood dyscrasias. Patients with delayed wound healing as a result of intravenous bisphosphonate treatment[8,9] or radiotherapy[10] also fall in this category. In addition, local factors such as the pneumatisation of the maxillary antrum around a single standing maxillary molar increases the risk of maxillary tuberosity fracture and/or oro-antral communication[11-13].

Overdenture abutments without attachments

Lone-standing teeth can be converted to root face abutments and used to provide partial support for overdenture appliance. Reduction of the crown height of lone-standing teeth improves the crown-root ratio and thereby the overall prognosis of the abutment. The retained roots maintain the contour of the bone to enhance the stability of the appliance[14].

Teeth used as root face abutments may require initial root canal treatment or subsequently suffer pulpal or peri-radicular complications as a result of coronal leakage and caries such that they then have to be endodontically treated[15,16]. In some instances retention of overdenture abutments can cause problems with interocclusal space due to the preservation of bone around these roots[17]. For the same reason, in the anterior region, the placement of a denture flange can be difficult and may result in distorting the natural appearance of the lip. Periodontal complications are also common especially where strict oral hygiene measures are not followed[15,16].

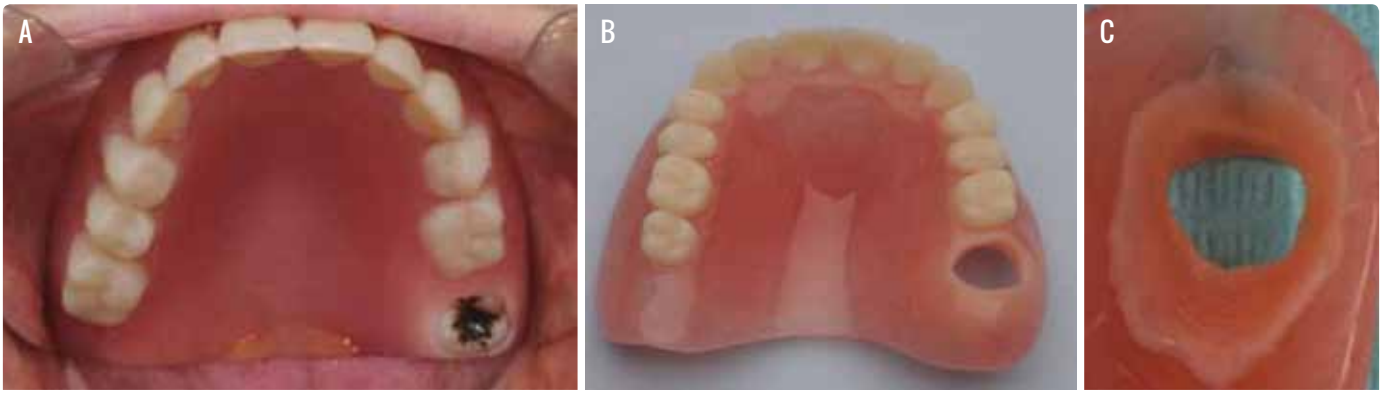

Figure 1. A, WRPD used to in the maxillary arch for a patient with a retained healthy 27. B, WRPD polished surface. C, Fitting surface of the WRPD in the window area showing the PSL cuff.

ACTIVE RETENTION

Metal clasps

Active retention and support can be sought when clasp assemblies (clasp, reciprocal arm and rest seat) engage lone-standing teeth. The use of clasps can be technically demanding as recontouring may be required to modify survey lines in order to provide adequate undercuts. Clasps can apply significant torqueing forces on lone-standing teeth especially in cases where cross-arch stabilisation is lacking. This in turn, may accelerate periodontal breakdown and ultimately tooth loss[6,18]. Clasps can also lead to tooth structure and restorative material abrasion[19], soft tissue trauma and act as plaque retentive factors increasing the risk of caries[20]. They may be aesthetically unacceptable for the patient when placed on anterior or premolar teeth[21]. The use of clasps inevitably results in breaching the peripheral seal of the denture.

Attachments

Precision or semi-precision attachments can be used with lone-standing teeth to retain overdentures or removable partial dentures. They have similar advantages to clasps but they are more aesthetically appealing. However, they are technically challenging, require regular maintenance due to wear of attachments' parts and can be costly. Catastrophic failures such as; root fracture, failure of attachment itself or the appliance framework are usually difficult to manage[22].

WINDOWED REMOVABLE PARTIAL DENTURE DESIGN WITH ELASTOMERIC RETENTION (WRPDS)

Principles, indications and advantages

WRPDs encircle teeth and utilise elastomeric materials (permanent soft liner, PSL) to engage undercuts around lone standing teeth[23]. WRPDs exploit the advantages seen with overdentures as they maintain teeth and supporting bone. In addition, the use of this design allows the development of optimum peripheral seal. Figure 1 & 2 shows the WRPD design when used for upper and lower arches.

In cases where remaining teeth have good periodontal bone support this may be regarded as the optimum design of the denture. In cases with compromised periodontal support the denture may be seen as a transitional appliance to which artificial teeth can be added when loss of natural teeth is inevitable.

WRPD design can be a viable alternative to other removable appliance designs in many cases such as; (1) extraction of remaining teeth is inadvisable, (2) impaired manual dexterity (peripheral neuropathy and Parkinson's disease) as it is safer and easier to insert and remove in comparison to RPDs with metal clasps, (3) severe bone resorption, (4) congenital or acquired defects in denture bearing areas and (5) RPDs opposed by natural dentition where maximum retention and stability is needed.

Using WRPD may be a psychological benefit to patients as a result of retaining natural teeth and delaying complete edentulism. It also can be valuable in allowing patient to adapt with a removable prosthesis when used as a transitional appliance. The use of this appliance reduces overloading of abutment teeth as with clasps.

Elastomeric Retention: Material Selection

PSLs are widely used to achieve two objectives, namely, cushioning and retention and may be used in many clinical situations. PSLs used in WRPD design provide protection of the remaining teeth against torqueing forces as well as enabling undercuts to be engaged and maximise retention. They can be classified according to their chemical composition into resin and silicone based liners. Both can be further subdivided to autopolymerising (cold-cured) and heated-cured liners. According to their cushioning ability, PSLs can be classified as elastic and viscoelastic materials[24]. In order to be used successfully in clinical practice, PSL material should provide a viscoelastic behaviour[25], which translates into effective cushioning of masticatory forces.

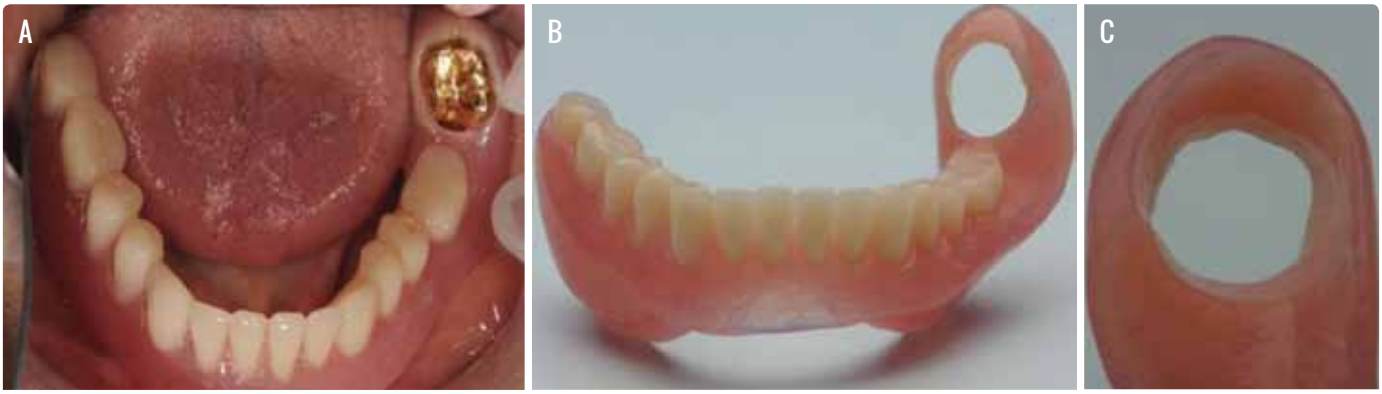

Figure 2. A, WRPD used to in the mandibular arch for a patient with a retained 38. B, WRPD polished surface. C, Fitting surface of the WRPD in the window area showing the PSL cuff.

Resin based PSLs are essentially plasticised acrylic resins that possess good viscoelastic behaviour[26] and high bond strength to acrylic denture bases. They contain a soluble plasticiser component that leaches out which subsequently causes water absorption, accelerated material degradation and increased surface roughness and porosity. This in turn results in discoloration and renders the surface of the PSL a good environment to harbour pathogenic microorganisms[27].

Silicone based PSLs are similar to silicone impression materials as far as chemical composition is concerned. They are also available in addition and condensation polymerisation reactions. Additional silicones are more stable as there is no by-product of the setting reaction. The silicone based PSL show better durability, surface integrity and colour and dimensional stability when compared with resin based counterparts[28]. This is attributed to the low water absorption and low solubility of components. However, they exhibit elastic rather than viscoelastic properties which indicate lower cushioning ability against masticatory forces. Bond strength of this type of PSLs to denture base materials was found to be inferior when compared to resin based analogues[29].

Construction of WRPD: Clinical Stages and Technical Considerations

Construction of WRPDs, from a clinical point of view, requires standard prosthodontic techniques. A high quality secondary impression is required for achieving optimum results. The number, distribution, condition and morphology of remaining teeth should be assessed carefully during treatment planning.

Posterior teeth are the preferred abutments as encircling anterior teeth with the denture base can cause the upper and/or lower lips to be overcontoured. Surveying abutment teeth on the master casts *(Figure 3)* is mandatory for the following reasons: (1) to study the path of insertion of prosthesis, (2) identify suitable undercuts and make informed decisions as to whether abutment teeth should be modified to create or reduce undercuts by addition of composite resin restorations or selective grinding and (3) identify where the denture base will contact tooth structure at the level of survey line and confine the PSL to the area of undercut.

Molloplast-B®, a heat cured, silicone based PSL was used in all WRPDs presented in this paper. The supplied silicone adhesive was applied to the denture bases prior processing the material according to manufacturers' instructions. It is worthwhile to mention that Molloplast-B® is one of the most durable PSLs. It also possesses reduced bacterial (Staphylococcus aureus) and fungal (Candida albicans) colonisation[30,31].

The acrylic denture base of soft-lined complete dentures are more liable to fracture which is ascribed to the reduced thickness of acrylic denture base to accommodate the soft liner[32]. In order to avoid cracking and breakage, the denture base around abutments should be thickened to ensure Acrylic-PSL ratio of 2:1. In cases where thickened denture base cannot be accommodated, high impact acrylic or cast metal denture base can be used *(Figure 4)*. Extra care should be taken when delivering the WRPDs to make sure that denture base around remaining teeth does not interfere with coronoid process, maxillary tuberosity or opposing teeth, if present. This can be accomplished using pressure indicating paste (PIP), occlusal indicator waxes and articulating papers *(Figure 5)*. This is considered essential as it prevents soreness, enhance stability and prolong the longevity of the prosthesis.

Application of primer materials to acrylic denture base was found to enhance the bond strength[33]. PSLs can also be bonded to air particle abraded and chemically primed Co–Cr denture bases. In order to get a more reliable bonding especially in environment with changing temperature, the use of an intermediate adhesive resin layer is highly recommended[34].

Application of surface sealer coatings to the PSLs is said to preserve initial characteristics of the PSLs such as; cleanness and resiliency, maintains surface integrity and it inhibits food stagnation and bacterial growth. However, it was found that

Figure 3. Lone standing tooth was surveyed on the model, wax spacer applied below survey line to provide space for PLS material. Denture base should contact the tooth at the survey line in order to prevent gum stripping action upon vertical displacement of the appliance.

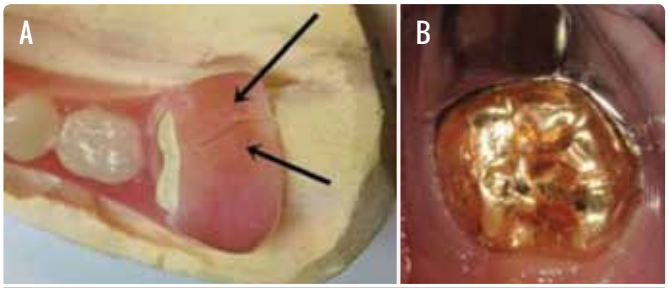

Figure 4. Elastomeric material weakens denture base and may cause denture base fracture (A). Thickening of denture base is the ideal solution but was precluded as a result of inadequate interocclusal clearance. Metal castings was used to alleviate this problem (B).

sealer coatings should be re-applied every 3 months[35]. In addition, application of a sealer coating had a pronounced protective effect on the surface of silicone based PSLs from tooth brush abrasion[36].

As with all removable prostheses, patients should have good oral hygiene standards. WRPDs increase the risk of caries periodontal problems in abutment teeth due to plaque accumulation as they cover significant amount of gingivae and tooth structure. Thorough oral and denture hygiene measures should be in place in order to prevent deterioration oral health. Patients should be advised to brush remaining teeth at least twice a day and in addition use chlorhexidine mouthwash once daily. Dentures should be rinsed after every meal and brushed with soap and water twice a day. Soaking the dentures frequently with sodium hypochlorite based solution is recommended. As with all removable prostheses, dentures should not be worn during sleep and kept in cold water when out of the mouth.

Patient should attend bi-annual review visits for check up on dentures and oral health. It is important to monitor signs of deterioration of elastomeric material. Deterioration of the material can compromise the peripheral seal and consequently the retention of the appliance. Thus, replacement of the elastomeric cuff should be done as soon as any of these signs is noticed. This can be done in a similar way to a denture relining procedure i.e. directly or indirectly. The old elastomeric cuff should be removed using scalpels and silicone burs. Silicone adhesive is then applied to the fitting surface of the denture and the window. A reline impression of the area is recorded in light bodied additional silicone impression material. A pick up impression using alginate is then required *(Figure 6)*. Undercuts should be blocked out and the impression poured up in stone. The fitting surface in the area of elastomeric ring is roughened using acrylic burs and then treated with primer according to manufacturer's instructions. The material is then syringed around abutment teeth on the cast and the denture fitted again on the cast. The denture is then processed with heat if the material is heat cured then finished and polished. The same procedure can be done chair-side when autopolymerising elastomeric materials used. No impression is needed and the material can be directly applied to denture base after removal of old material and primer treatment.

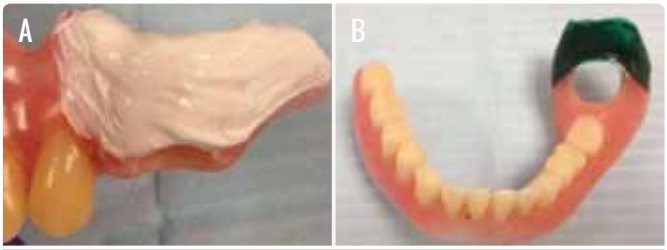

Figure 5. Thickened denture base can interfere with surrounding structured which should be checked carefully using PIP (A) or occlusal indicator wax (B).

DISCUSSION

The decision to remove an isolated but sound tooth, particularly in elderly patients prior to the provision of a removable prosthesis, requires careful consideration. In each case the clinician is required to weigh up both the risks and benefits of extracting the tooth. In comparison to other treatment approaches, the WRPD design may offer a superior clinical outcome as it combines the advantages of a complete denture and overdenture in terms of peripheral seal with the use of active retentive components associated with partial dentures. Maintenance of teeth preserves the alveolar ridge height and thereby improves the stability of the prosthesis. In the event of loss of retention as result of damage, deterioration or distortion of elastomeric retention cuff, the situation can be rectified quite easily. This is in contrast to the situation with cast clasps where modifications are often difficult to achieve. In addition, the WRPDs can be simply converted to conventional complete denture should the remaining teeth be lost.

The construction of WRPD requires no sophisticated armamentarium or additional skills to those needed for complete denture construction. However, meticulous designing, processing and insertion are required to ensure durability of the appliance and patient satisfaction. Additionally, thorough homecare and regular recall visits are of a paramount importance in order to diagnose/treat deterioration of elastomeric material and any other pathology affecting remaining teeth or underlying mucosa.

CONCLUSION

The WRPD offers an alternative design of partial denture for patients with lone standing teeth. The design may be considered either transitional or permanent and offers a method of gaining maximum advantage of the retention and support provided by retaining natural teeth without the loss of peripheral seal.

MANUFACTURER'S DETAILS

- Molloplast B® (Detax Gmbh & Co., KG, Germany)

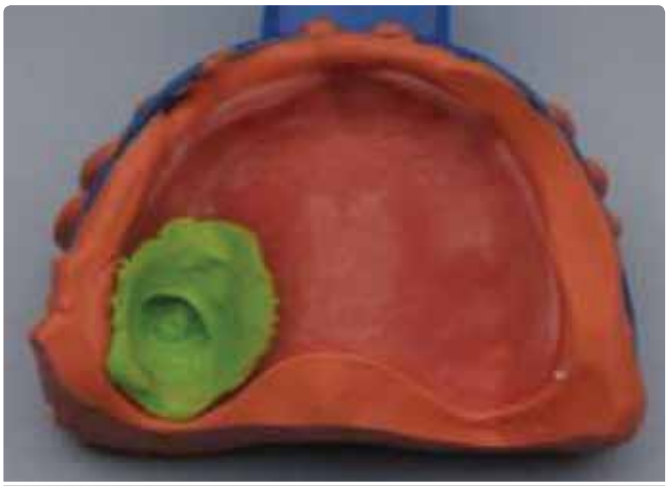

Figure 6. Reline silicone and pick-up alginate impressions for indirect replacement of the elastomeric cuff of WRPD

REFERENCES

1. Douglass, C.W., Shih, A. and Ostry, L. Will there be a need for complete dentures in the United States in 2020? *J Prosthet Dent*., 2002; **87**(1):5-8.
2. van Waas, M.A.J. The influence of clinical variables on patients' satisfaction with complete dentures. *J Prosthet Dent*., 1990; **63**(3):307-310.
3. Langer, A., Michman, J. and Seifert, I. Factors influencing satisfaction with complete dentures in geriatric patients. *J Prosthet Dent.* 1961; **11**(6):1019-1031.
4. Boerrigter, E.M., Geertman, M.E. and Van Noort, R.P., *et al.* Patient satisfaction with implant-retained mandibular overdentures. A comparison with new complete dentures not retained by implants -a multicentre randomized clinical trial. *Brit J Oral Max Surg.* 1995; **33**(5):282-288.
5. Basker, R.M., Davenport, J.C. and Thomason, J.M. Prosthetic Treatment of the Edentulous Patients. 5th edn. *John Wiley & Sons*, 2011; 55-67
6. McGivney GP, Carr AB. McCracken's Removable Partial Prosthodontics. *Mosby*; 2000.
7. Zitzmann NU, Krastl G, Hecker H, Walter C, Waltimo T, Weiger R. Strategic considerations in treatment planning: Deciding when to treat, extract, or replace a questionable tooth. *J Prosthet Dent.* 2010;**104**:(2): 80-91.
8. Bamias A, Kastritis E, Bamia C, Moulopoulos LA, Melakopoulos I, Bozas G, *et al.* Osteonecrosis of the Jaw in Cancer After Treatment With Bisphosphonates: Incidence and Risk Factors. *J Clin Oncol.* 2005;**23**(34):8580-7.
9. Marx RE, Sawatari Y, Fortin M, Broumand V. Bisphosphonate-Induced Exposed Bone (Osteonecrosis/Osteopetrosis) of the Jaws: Risk Factors, Recognition, Prevention, and Treatment. *J Oral Maxil Surg.* 2005: **63**(11):1567-75.
10. Reuther T, Schuster T, Mende U, KÃbler A. Osteoradionecrosis of the jaws as a side effect of radiotherapy of head and neck tumour patients: a report of a thirty year retrospective review. *Int J Oral Max Surg.* 2003;**32**(3):289-95.
11. Coulthard P, Horner K, Sloan P, Theaker ED. Master Dentistry, Volume 1: Oral and Maxillofacial Surgery, Radiology, Pathology and Oral Medicine,3: Master Dentistry. Elsevier - Health Sciences Division; 2013.
12. Peterson L. Contemporary Oral and Maxillofacial Surgery. Mosby; 2003.
13. Bell G. Oro-antral fistulae and fractured tuberosities. *Brit Dent J* 2011;**211**(3):119-23.
14. Preiskel HW. Precision Attachments in Prosthodontics: Overdentures and telescopic prostheses. *Quintessence Publishing Company*; 1985.
15. Reitz PV, Weiner MG, Levin B. An overdenture survey: Preliminary report. *J Prosthet Dent.* 1977;**37**(3):246-58.
16. Reitz PV, Weiner MG, Levin B. An overdenture survey: Second report. *J Prosthet Dent* 1980;**43**(4):457-62.
17. Preston AJ. Removable Prostheses Revisited: Challenges for Primary Dental Care. 3. Overdentures. *Prim Dent Care.* 2007;**14**(4):145-8.
18. Vermeulen A, Keltjens H, Van't Hof MA, Kayser AF. Ten-year evaluation of removable partial dentures: survival rates based on retreatment, not wearing and replacement. *J Prosthet Dent.* 1996;**76**(3):267-72.
19. Hebel KS, Graser GN, Featherstone JDB. Abrasion of enamel and composite resin by removable partial denture clasps. *J Prosthet Dent.* 1984;**52**(3):389-97.
20. Krol AJ. Clasp design for extension-base removable partial dentures. *J Prosthet Dent.* 1973;**29**(4):408-15.
21. Suh JS, Billy EJ. Rotational Path Removable Partial Denture (RPD): Conservative Esthetic Treatment Option for the Edentulous Mandibular Anterior Region: A Case Report. *J Esthet Restor Dent.* 2008;**20**(2):98-105.
22. Owall B, JÃnsson L. Precision attachment-retained removable partial dentures. Part 3. General practitioner results up to 2 years. *Int J Prosthodont.* 1997;**11**(6):574-9.
23. Perkins NJ NP, Dillon S. The windowed partial denture: Application of an elastomeric retention technique. *Quintessence Dent Technol.* 2006;**4**(4):254-64.
24. McCabe, J.F. Soft lining materials: composition and structure. *J Oral Rehabil*. 1976; **3**(3):273-278.
25. Murata, H., Haberham, R.C., Hamada, T. and Taguchi, N. Setting and stress relaxation behaviour of resilient denture liners. *J Prosthet Dent.* 1998; **80**(6):714-722.
26. Murata, H., Taguchi, N., Hamada, T., Kawamura, M. and McCabe, J.F. Dynamic viscoelasticity of soft liners and masticatory function. *J Dent Res.* 2002; **81**(2):123-128.
27. Gronet, P.M., Driscoll, C.F., and Hondrum, S.O. Resiliency of surface-sealed temporary soft denture liners. *J Prosthet Dent.* 1997; **77**(4):370-374.
28. Hekimoğlu, C. and Anil, N. The effect of accelerated ageing on the mechanical properties of soft denture lining materials. *J Oral Rehabil.* 1999; **26**(9):745-748.
29. Dootz, E.R., Koran, A. and Craig, R.G. Physical property comparison of 11 soft denture lining materials as a function of accelerated aging. *J Prosthet Dent.* 1993; **69**(1):114-119.
30. Pavan, S., Dos Santos, P.H., Filho, J.N.A. and Spolidorio, D.M.P. Colonisation of soft lining materials by micro-organisms. *Gerodontology*. 2010; **27**(3):211-216.
31. Cal, E., Kesercioglu, A., Sen, B.H. and Cilli, F. Comparison of the hardness and microbiologic adherence of four permanent denture soft liners. *Gen Dent.* 2005; **54**(1):28-32.
32. Watts, D.C. An examination of the stress distribution in a soft-lined acrylic resin mandibular complete denture by finite element analysis. *Int J Prosthodont.* 2000; **13**(1):19-24.
33. Minami, H., Suzuki, S., Ohashi, H., Kurashige, H. and Tanaka, T. Effect of surface treatment on the bonding of an autopolymerizing soft denture liner to a denture base resin. *Int J Prosthodont.* 2003; 17 (3):297-301.
34. Minami, H., Suzuki, S., Minesaki, Y., Kurashige, H. and Tanaka, T. In vitro evaluation of the effect of thermal and mechanical fatigues on the bonding of an autopolymerizing soft denture liner to denture base materials using different primers. *J Prosthodont.* 2008; **17**(5):392-400.
35. Dayrell, A., Takahashi, J., Valverde, G., Consani, R., Ambrosano, G. and Mesquita, M. Effect of sealer coating on mechanical and physical properties of permanent soft lining materials. *Gerodontology*. 2012; **29**(2):401-407.
36. Mainieri, V.C., Beck, J., Oshima, H.M., Hirakata, L.M. and Shinkai, R.S. Surface changes in denture soft liners with and without sealer coating following abrasion with mechanical brushing. *Gerodontology*. 2011; **28**(2):146-151.