

Effect of soft liner on clinical implication of tooth supported overdenture

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Background/aim

Overdentures are considered as the most preferred treatment modality in patients with few remaining teeth, especially after using different denture liners. The present study aims to compare between the clinical performance of tooth supported overdentures relined with three different types (hard denture liner, silicon soft liner, and acrylic resin based soft liner) regarding modified bleeding index, probing depth, and patient satisfaction.

Patients and methods

A total of 21 partially edentulous patients with one remaining tooth on each side received overdentures constructed with conventional method after abutment preparation. Then dentures were classified randomly into three groups according to relining material: group I was relined with hard liner, group II was relined with silicon soft liner, and group III was relined with acrylic resin soft liner. All patients were recalled after 1, 3, and 6 months. At recall visits, assessment of the oral health status was performed by measuring probing depth and modified bleeding index by using periodontal probe. Moreover, patient satisfaction was evaluated using Oral Health Impacts Profile-14 questionnaire.

Results

One-way analysis of variance (ANOVA) was performed to compare among the three groups, which revealed significant difference between them in all follow-up periods regarding modified bleeding index, probing depth, and patient satisfaction, followed by Tukey's post-hoc test for multiple comparisons, which revealed a significant difference among all groups ($P < 0.05$). On the contrary, comparison was performed between different follow-up periods in each group by repetitive one-way ANOVA test, which revealed a significant difference in all groups regarding modified bleeding index and probing depth, whereas revealed insignificant difference in patient satisfaction. Repetitive one-way ANOVA test was followed by Tukey's post-hoc test for multiple comparisons, which revealed significant difference between T1 and T2 and between T1 and T3 in all groups regarding modified bleeding index, whereas revealed a significant difference between T1 and T3 in all groups regarding probing depth, but in patient satisfaction, insignificant difference was revealed.

Conclusion

Acrylic resin soft liner showed the best clinical performance then silicon soft liner followed by hard liner regarding modified bleeding index, probing depth, and patient satisfaction during the follow-up period.

Keywords:

acrylic resin soft liner, modified bleeding index, overdenture, patient satisfaction, silicon

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Introduction

An overdenture is considered as removable prosthesis that may be complete or partial, and also it covers and rests on one or more remaining natural teeth, the roots of natural teeth, and/or dental implants [1]. This treatment modality could be described by several terms such as overlay denture, telescopic dentures, tooth supported dentures, hybrid prosthesis, crown and sleeve prosthesis, and the superimposing dentures [2].

Overdenture is considered as one of the best concepts in preservative prosthodontic dentistry owing to

preservation of remaining natural teeth. There are two physiologic principles associated with this therapy: the primary concerns the maintenance of alveolar bone around the remained teeth, whereas the secondary concerns the maintenance of the present periodontal sensory mechanisms that manual and monitor gnathodynamic functions [3].

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Continuous bone resorption is one of main problems associated with overdentures which requires either relining or reconstruction of new dentures to decrease torqueing effect on abutments, as well as pain and discomfort induced by improper fitness, support, and retention of dentures [4]. Overdenture relining is more practical than reconstruction of new one to improve adaptation to denture-bearing area as it saves time and less cost, on the condition that occlusion, contour, extension, and esthetics are acceptable [5].

There are two types of denture relining materials used: hard and soft liners. Hard relining materials are divided into several types according to curing method: heat cured, self-cured, or light cured. However, soft liners are divided into four groups based on chemical structures: plasticized acrylic resins (chemical or heat cured), vinyl resins, rubbers (polyurethane and polyphosphazene type), and silicone rubbers [5,6].

Hard liners are clinically used for better retention, fitness, and stability of poorly fitted dentures. However, soft liners are used in patients complaining of pain or discomfort depending on its cushioning effect by forming a cushioned layer between the hard denture base and the oral mucosa, which distribute the forces of mastication evenly to the underlying tissues and by absorbing some of the masticatory forces [7].

Accordingly, soft liners are recommended in cases of irregular bone resorption, immediate prosthesis, healing after implant placement, patients with bruxism, xerostomia, ridge atrophy, thin and nonresilient mucosa and bony undercuts owing to its ability to improve denture comfort in patients [8].

The acrylic resin soft liner composed of a powder consisting of acrylic polymers, plasticizers, and copolymers, whereas liquid consisting of acrylic monomer. The plasticizers are responsible for maintaining the material softness that improve its cushioning effect. On the contrary, the silicone elastomers, consisting of dimethyl siloxane polymers, with a chemical composition like that of the silicone impression materials, are not dependent on leachable plasticizers and, therefore, retain their elastic properties for prolonged periods that improve its durability [5,9].

The desirable physical, mechanical, and biological properties of soft liner have great effect on its success such as cushioning effect on the mucosa, dimensional stability, permanent resiliency, minimal fluid sorption and solubility, and inhibitory action on

fungal growth [10], in addition to ease of processing, ease of finishing and polishing, and adhesion to denture base but no effect upon denture resin. The success or failure of a soft liner is dependent not only upon the physical, mechanical, and biological properties of the material employed but also on the understanding of the intended function of these products, and the physiological and biological properties of resilient oral tissues upon which the denture rests [11].

Clinical evaluation of abutment teeth, alveolar mucosa, bone resorption around abutment, and denture adaptation is mandatory to check overdenture success, which is assessed by several parameters such as bleeding index, pocket depth, and patient satisfaction [12].

The papillary bleeding index is the main parameter in assessing the health status of periodontal tissues as it was used to assess potential inflammation [13]. If there is no bleeding after probing, it expects stable periodontal condition. Modified papillary bleeding index according Barnett *et al.* [14] is the most recent used index, which divided into 4 scores: score 0, no bleeding within 30 s of probing; score 1, bleeding between 3 and 30 s of probing; score 2, bleeding within 2 s of probing; and score 3, bleeding immediately upon probe placement.

In addition, probing depth is very important parameter to assess health status of periodontium around abutment and to evaluate effect of overdenture on it; periodontal probe is used to measure probing depth should be long, thin and blunt at end to avoid tissue injury [15].

Evaluation of patients' acceptance and satisfaction with their overdentures therapy may be performed by various methods. Patient satisfaction questionnaire can be considered as a very important tool to assess clinical implication of tooth supported overdenture which may be anticipated to patient ability to adapt and be satisfied with their inadequate overdentures [16,17].

One of the most accurate methods to monitor patient satisfaction is Oral Health Impacts Profile-14 (OHIP-14) questionnaire as it can evaluate functional limitation, pain, psychological discomfort, social disability, physical disability, and general satisfaction. The OHIP-14 uses a scale of five categories (1=never, 2=hardly ever, 3=occasionally, 4=fairly often, and 5=very often) [18,19].

The aim of this study was to evaluate the effect of different relining materials (hard liner, silicon soft

liner, and acrylic resin soft liner) on oral health-related quality of life by determination of modified bleeding index, probing depth, and patient satisfaction.

Patients and methods

Patients

This study was carried out in the Department of Removable prosthodontics Faculty of Oral and Dental Medicine, Al-Ahram Canadian University and in the Department of Fixed and Removable prosthodontics at National Research Center. The participants of this study were 21 patients after calculating the sample size by PS program. Random distribution of total sample size on the three studied groups was performed equally with seven patients only for each group.

Study design

In this case-control study, 21 patients were divided randomly into three groups according to relining material; each group contains seven patients. Group I had overdentures relined with hard relining material (Acrostone Dental and Medical Supplies, Heliopolis, Cairo, Egypt), group II had overdentures relined with silicon soft liner (Tokuyama Dental Corporation, Tokyo, Japan; <http://www.tokoyama-dental.com>), whereas group III had overdentures relined with acrylic soft liner (DENTSPLY International Inc., York, Pennsylvania, USA; <http://www.austenal.dentsply.com> or

<http://www.dentsply.com>). All patients were recalled after 1, 3, and 6 months to evaluate the oral health status by assessment of modified papillary bleeding index, probing depth of the abutments, and to evaluate patient satisfaction by OHIP-14 questionnaire.

Ethical consideration

All participants were informed about the nature of this research work and their approvals were obtained through a written consent form. Ethical approval certificate was obtained from National Research Center Ethical Committee, with approval no 190/97. Only those who showed cooperation and acceptance for compliance to treatment and recall were included.

Inclusion and exclusion criteria

The basic inclusion criteria were partially edentulous patients with one remaining tooth on each side (either canine or first premolars mandibular teeth), good oral hygiene measures, and proper interrace distance. All selected patients included were nonsmoker males, and their age ranged from 40 to 60 years old. On the contrary, uncooperative and undermotivated patients,

mentally and physically handicapped patients, patients with systemic diseases, TMJ disorders, bad oral habits such as clenching or bruxism, and intaking medications that may affect oral health status were excluded.

Methods

Abutment preparation

Treatment plane started with proper selection of abutments after clinical assessment and review of study casts and radiographs. The patients were referred to the department of periodontics for therapeutic oral prophylaxis and Department of Oral Surgery for extraction of teeth with unfavorable conditions (other than those selected as abutments).

Abutments of root canal were treated then prepared to receive metal coping as follows: a height of 2–3 mm occluso-gingivally with apical chamfer finish line at dento-gingival junction. A cylindrical channel with antirotation extension prepared in pulp canal developed the space for short dowels cast as a part of the metallic copings. This greatly enhanced retention of copings. Then impressions were made using regular body silicone impression material and poured in die-stone (Fig. 1). Copings were cast using standard technique. These were cast using a nickel–chromium alloy (REMANIUM-G SOFT DENTAURM). Finished copings were cemented using glass ionomer cement (Fuji 1, GC Corp., Hongo, Bunkyo-ku, Tokyo, Japan; www.gc-dental.com).

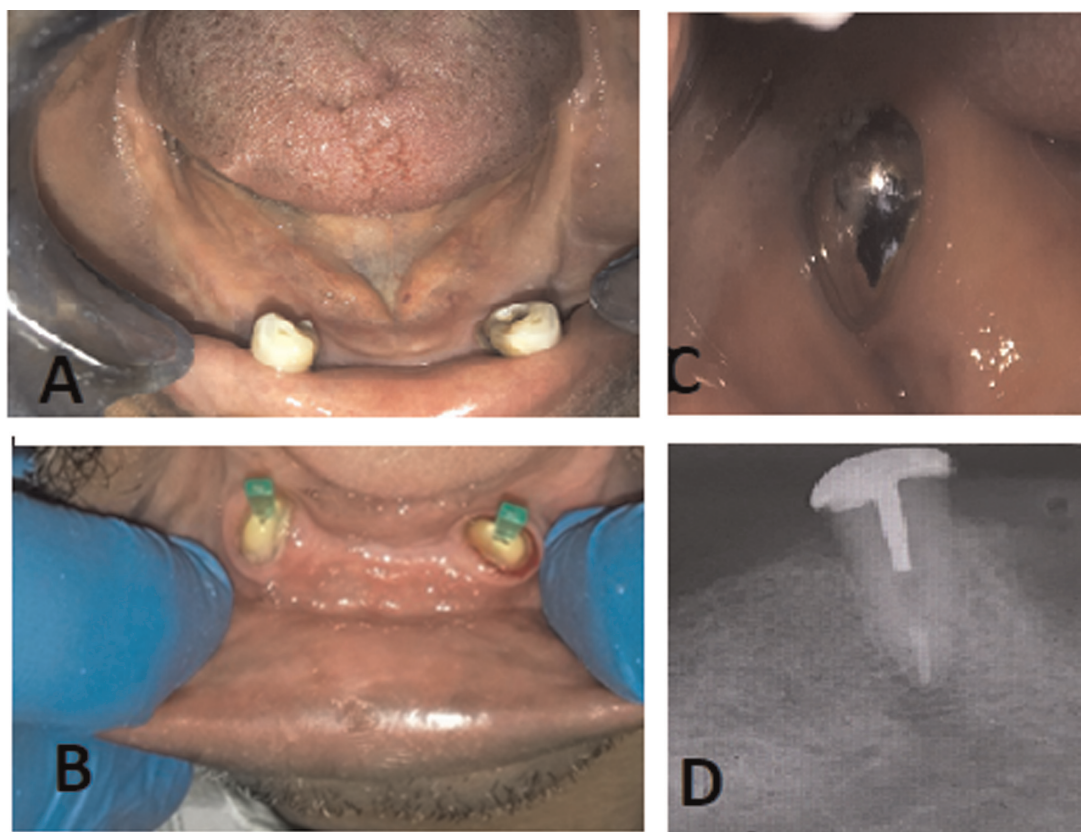
Denture fabrication

After abutment preparation, the procedure of making dentures was like that used for the making of conventional acrylic dentures. Irreversible hydrocolloid impression material was used for primary impression, whereas low fusing compound and regular body elastomeric impression material were used for border molding and final impression. Master casts were obtained from final impression and then occlusal blocks were fabricated to record maxillo-mandibular relations. Try-in of trial denture was made in patient's mouth to check proper fit, border extensions, occlusion, phonetics, vertical and centric relation, and finally, esthetics. Then final dentures were obtained after curing with regular processing technique.

Denture relining

Patients were classified randomly into three groups according to relining material used; each group consisted of seven dentures. Relining materials were used following manufacturer recommendations: group I (control group) used hard relining material (Acrostone Dental & Medical Supplies), group II

Figure 1



Abutment preparation: (a) proper selection of teeth, (b) prepare teeth to receive dowel post, (c) isolated x abutment with metallic coping, and (d); x-ray show endodontically treated tooth with metallic post.

used silicon soft liner (Tokuyama Dental Corporation; <http://www.tokoyama-dental.com>), and group III used acrylic soft liner (DENTSPLY International Inc.; <http://www.austenal.dentsply.com> or <http://www.dentsply.com>).

Patient instructions

The patients were given the usual home care instructions about wearing and caring of dentures and remaining abutments. Regarding abutments, gentle cleaning and massage with soft toothbrush, as well as frequent use of mouth washes was explained. However, regarding dentures, removal of them at night and cleaning with denture brush and mild soap was required.

Recall

Recall visits schedule followed was after 1, 3, and 6 months. At recall visits, evaluation of the oral health status was performed by assessment of the abutments regarding the following.

Modified papillary bleeding index

It was performed by careful isolation and drying the area around the abutments, and then using periodontal probe with standardized size and force by placing it in

the gingival sulcus at the mesial and distal line angles of the tooth surface to be examined and carefully swept forward into the papilla.

Then, the appearance of bleeding was timed and graded it as follows: 0=no bleeding within 30 s of probing; 1=bleeding between 3 and 30 s of probing; 2=bleeding within 2 s of probing; and 3=bleeding immediately upon probe placement. Then the mean of both mesial and distal line angles readings was calculated.

Probing depth

The distance between the marginal border of the mucosa and the tip of the periodontal probe was measured using periodontal probe. Probing depth was measured at four sites of each abutment (mesially, labially, distally, and lingually), and the mean value for all surfaces of each abutment was calculate.

Patient satisfaction

The questionnaire was an OHIP-14 questionnaire, and the lower score indicates higher satisfaction.

Table 1 The oral health impacts profile-14 questionnaire

		1	2	3	4	5
1	Have you had trouble pronouncing any words?	Never	Hardly ever	Occasionally	Fairly often	Very often
2	Have you felt that your sense of taste has worsened?	Never	Hardly ever	Occasionally	Fairly often	Very often
3	Have you had painful aching in your mouth	Never	Hardly ever	Occasionally	Fairly often	Very often
4	Have you found it uncomfortable to eat any foods?	Never	Hardly ever	Occasionally	Fairly often	Very often
5	Have you been self-conscious because of your dentures?	Never	Hardly ever	Occasionally	Fairly often	Very often
6	Have you felt tense?	Never	Hardly ever	Occasionally	Fairly often	Very often
7	Has your diet been unsatisfactory?	Never	Hardly ever	Occasionally	Fairly often	Very often
8	Have you had to interrupt meals?	Never	Hardly ever	Occasionally	Fairly often	Very often
9	Have you found it difficult to relax?	Never	Hardly ever	Occasionally	Fairly often	Very often
10	Have you been a bit embarrassed?	Never	Hardly ever	Occasionally	Fairly often	Very often
11	Have you been a bit irritable with other people?	Never	Hardly ever	Occasionally	Fairly often	Very often
12	Have you had difficulty doing your usual jobs?	Never	Hardly ever	Occasionally	Fairly often	Very often
13	Have you felt that life in general was less satisfying?	Never	Hardly ever	Occasionally	Fairly often	Very often
14	Have you been totally unable to function?	Never	Hardly ever	Occasionally	Fairly often	Very often

Table 2 Modified bleeding index of three groups during follow up periods

Groups	Modified bleeding index		
	T1 (after 1month)	T2 (after 3 months)	T3 (after 6 months)
Group I (hard liner)	1.41±0.41 ^{a,A}	1.92±0.52 ^{b,A}	2.35±0.49 ^{b,A}
Group II (silicon soft liner)	0.98±0.28 ^{a,B}	1.41±0.36 ^{b,B}	1.63±0.42 ^{b,B}
Group III (acrylic resin soft liner)	0.53±0.17 ^{a,C}	0.91±0.23 ^{b,C}	1.11±0.32 ^{b,C}

All data are presented as mean±SD. ^{A,B,C}The different letters are significant within the same raw at *P* value less than 0.05. ^{a,b,c}The different letters are significant within the same column at *P* value less than 0.05.

Table 3 Probing depth of three groups during follow up periods

Groups	Probing depth		
	T1 (after 1month)	T2 (after 3 months)	T3 (after 6 months)
Group I (hard liner)	1.26±0.33 ^{a,A}	1.61±0.36 ^{a,A,B}	1.91±0.47 ^{a,B}
Group II (silicon soft liner)	0.82±0.31 ^{b,A}	1.11±0.29 ^{b,A,B}	1.41±0.23 ^{b,B}
Group III (acrylic resin soft liner)	0.43±0.12 ^{c,A}	0.65±0.15 ^{c,A,B}	0.91±0.12 ^{c,B}

All data are presented as mean±SD. ^{A,B,C}The different letters are significant within the same raw at *P* value less than 0.05. ^{a,b,c}The different letters are significant within the same column at *P* value less than 0.05.

Statistical analysis

All data are presented as mean and SD. Data were explored for normality using Kolmogorov–Smirnov and Shapiro–Wilk tests that revealed normal data. One-way analysis of variance (ANOVA) was performed to compare between three groups followed by Tukey's post-hoc test for multiple comparisons, whereas repetitive one-way ANOVA was used to compare between different follow-up periods in each group. Statistical analysis was performed with IBM SPSS (Statistics version 24 for Windows; SPSS Inc., IBM Corporation, New York, New York, USA).

Results

The present results indicated that, in comparison among three groups regarding modified bleeding index, which was performed using one-way ANOVA, group I (hard reliner) was significantly the

highest (1.41±0.41, 1.92±0.52, and 2.35±0.49), followed by group II (silicon soft reliner) (0.98±0.28, 1.41±0.36, and 1.63±0.42), whereas the significantly lowest was group III (acrylic resin soft liner) (0.53±0.17, 0.91±0.23, and 1.11±0.32) for T1, T2, and T3, respectively, as presented in Tables 1 and 2.

Regarding probing depth comparison among three groups, which was also performed using one-way ANOVA, group I (hard reliner) was significantly the highest (1.26±0.33, 1.61±0.36, and 1.91±0.47), followed by group II (silicon soft reliner) (0.82±0.31, 1.11±0.29, and 1.41±0.23), whereas the significantly lowest was group III (acrylic resin soft liner) (0.43±0.12, 0.65±0.15, and 0.91±0.12) for T1, T2, and T3, respectively, as presented in Table 3.

Moreover, comparison regarding patient satisfaction among the three groups, which also was performed using one-way ANOVA, revealed that group I (hard

Table 4 Patient satisfaction of three groups during follow up period

Groups	Patient satisfaction		
	T1 (after 1 month)	T2 (after 3 months)	T3 (after 6 months)
Group I (hard liner)	45.7±9.8 ^{a,A}	41.3±6.9 ^{a,A}	43.6±7.8 ^{a,A}
Group II (silicon soft liner)	35.6±8.1 ^{b,A}	32.3±6.7 ^{b,A}	27.3±5.6 ^{b,A}
Group III (acrylic resin soft liner)	24.1±5.2 ^{c,A}	20.6±6.3 ^{c,A}	18.2±4.9 ^{c,A}

All data are presented as mean±SD. ^{A,B,C}The different letters are significant within the same raw at *P* value less than 0.05. ^{a,b,c}The different letters are significant within the same column at *P* value less than 0.05.

reline) was significantly the highest (45.7±9.8, 41.3±6.9, and 43.6±7.8), followed by group II (silicon soft reline) (35.6±8.1, 32.3±6.7, and 27.3±5.6), whereas the significantly lowest was group III (acrylic resin soft liner) (24.1±5.2, 20.6±6.3, and 18.2±4.9) for T1, T2, and T3, respectively, as presented in Table 4.

Comparison was performed between different follow-up periods in each group regarding modified bleeding index, which revealed significant difference between them in three groups (*P*<0.05), followed by Tukey's post-hoc test, which revealed that T1 was significantly lower than T2 and T3 in three groups, as presented in Table 2. However, regarding probing depth, it was revealed significant difference (*P*<0.05) between T1 and T3 in all groups, as presented in Table 3. On the contrary, it revealed insignificant difference between them regarding patient satisfaction in three groups (*P*>0.05), as presented in Table 4.

Discussion

Despite persistent marketing for implant dentistry, teeth supported overdenture therapy is considered as one of the most preferred alternative treatments nowadays, as it is more conservative, less costly, and time saving [20]. The overdenture treatment success depends on selection of strategic abutments with proper endodontic and periodontal therapy, as well as proper instructions followed by the patients [21].

Patients inclusion and exclusion criteria were mainly directed toward elimination of the possible factors that could affect oral health status of patients and denture adaptation, which has a great effect on bleeding index, probing depth, and patient satisfaction, such as hormonal imbalance, acquired immune-deficiency disease, medications, smoking, and physical condition of patients to follow instruction about wearing and care of dentures and remaining abutments [22].

At denture delivery, the usual home care instructions were given to all patients regarding overdentures and remaining abutments cleaning, removal of

overdentures at night, and message of remaining abutments using fluoride toothpaste. All these given instructions were very important to control plaque accumulation and microbial flora that influence bleeding, pocket depth, and patient satisfaction [23].

Oral and general health status has great effect on life quality. In edentulous patients, the performed prosthodontic rehabilitation plays an important role in oral health. Modified bleeding index, pocket depth, and patient satisfaction are very important factors to assess oral health status and overdenture success. For result standardization, standardized force was applied by periodontal probe with blunt end to determined modified bleeding index and evaluate probing depth [24]. Moreover, OHIP-14 index was used in this study to evaluate and compare the effect of using teeth supported overdenture utilizing different types of denture liners. OHIP-14 questionnaire is considered as one of the most accurate and frequently used instruments nowadays [25].

In this study, overdentures relined with soft liners had the lower modified bleeding index, probing depth, and patient satisfaction results. On the contrary, overdentures relined with hard liners revealed higher results during follow-up period. These results may be related to several factors such as different chemical structure that influence the clinical behavior of the relined denture, in addition to the cushioning effect of soft liners that absorbs and distributes forces, thus reduces both stresses on abutment and bone, which decreases gingival tissue trauma and prevents alveolar bone loss [26].

In addition, bleeding and probing depth of abutments are directly affected by increased microorganisms' adhesion in overdentures relined with hard liners. Microorganisms' adhesion may be attributed to release of residual monomers and plasticizers, inducing porosity and roughness, which increase after disinfection with several methods such as immersion in sodium perborate and radiation with microwaves owing to the immersion temperature and oxygen release by the perborate. Moreover,

microorganism adhesion induces offensive odor and decreases esthetics, and accordingly, patient satisfaction decreased as well [27]. On the contrary, overdentures relined with acrylic resin soft liners revealed better results regarding modified bleeding index, probing depth, and patient satisfaction than overdenture relined with silicon soft liner, which may be attributed to that acrylic resin soft liner materials exhibited viscoelastic behavior, whereas silicone soft liners materials exhibited elastic behavior [28].

Thus, the acrylic soft liners would have a higher cushion effect and lower durability, whereas silicone permanent soft liners have higher durability and lower cushioning effect. Higher cushioning effect plays a great role in force distribution, denture comfort, and improvement of oral health status. Accordingly, the acrylic materials can be used when patient complains of pain and is not satisfied with denture, but it should be replaced more frequently than silicone products because of lower durability. So, selection of soft liners depends on the clinical situations [29].

The results of this study are in agreement with Hiroshi *et al.* [26], who demonstrated that using soft liners with viscoelastic properties (acrylic resin soft liners) in mandibular complete dentures of patients suffering from pain during mastication revealed great development in masticatory function and comfort owing to its cushioning effect, which relieves pain during mastication and recommended for additional research studies to produce the ideal soft denture liners with higher cushioning effect and higher durability.

Conclusion

The present study concluded that soft liners demonstrated better results than hard liners in modified bleeding index, probing depth, and patient satisfaction. Moreover, it has been found that acrylic resin soft liner is better than silicon soft liner regarding modified bleeding index, probing depth, and patient satisfaction owing to its higher cushioning effect. More investigations will be needed to obtain soft liner with high cushioning effect with high durability at the same time.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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