



White paper on guidelines for the use of denture adhesives and their benefits for oral and general health

○ **Global Task Force for
Development of Guidelines
on Use of Denture Adhesives**

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Executive summary

By 2050 there are expected to be 2 billion people aged 60 years or older. This is more than double today's figure. The older you are, the more likely you are to have lost all, or nearly all, your natural teeth.

Research shows that around the world there are almost no guidelines on the proper use of denture adhesives by people who wear full dentures. There are only a few guides from dental associations and opinion leaders for denture wearers on how to use denture adhesives properly. Equally, dental professionals are uncertain about when is the best time to give advice.

This means denture wearers can be left without any guidance on how best to use denture adhesives. Also, the advice on the type of adhesive to use, how to apply it, how much to use, how often to use it and how to remove it varies tremendously. Misusing or overusing adhesive may have consequences – but making the best use of it can improve quality of life, quality of diet and overall wellbeing for full-denture wearers.

We carried out a comprehensive search of online and other available sources for guidelines for full-denture wearers on using denture adhesives. We found only limited guidelines or recommendations. There are several types of denture adhesives on the market. Adhesive creams seem to be the most researched and are the only ones with some consistent usage instructions. Because we found only limited information on adhesive powders and strips, and because their use is also not as widespread as that of creams, we did not include these in this review. Information was also scarce on insoluble adhesives such as cushion pads, and we therefore did not include these in our review either.

Therefore we have developed guidelines to guide dental health care professionals, caregivers and patients on the optimal use of denture adhesive creams. These are supported by best evidence and based on consensus from key international experts.

- 1. Apply a small amount of denture adhesive cream to a clean and dry denture. One application a day should be sufficient.**
- 2. After application, replace the denture in the mouth and firmly close the mouth for a couple of seconds. If the adhesive cream overflows, too much has been applied and the adhesive should be removed (rather than swallowed). Patients should not consume food or drink within the first 5 minutes of application.**
- 3. Before sleep, the denture should be removed and the denture and oral cavity thoroughly cleaned to remove any remaining adhesive.**
- 4. All patients who wear removable dentures should be enrolled into a regular recall and maintenance programme with their dental professional.**

The benefits of the optimal use of denture adhesives with full dentures are in improved:

- retention
- stability
- patient-perceived masticatory function, and
- masticatory performance and effectiveness.

Research has shown that food trapping and microbial growth can be reduced with an optimal use of denture adhesives. All these benefits may help enhance the patient's wellbeing, and improve their diet and social interaction.

We have developed our science-based guidelines on the optimal use of denture adhesive creams to help improve patients' wellbeing and overall health.

- 1. Patient satisfaction has become a decisive factor for the overall success of prosthodontic treatment in full-denture wearers.**
- 2. Denture adhesives can enhance the retention of, and reduce food accumulation beneath, well-fitting complete dentures.**
- 3. Denture adhesives can be beneficial to the patient. They may enhance comfort, provide psychological satisfaction, increase confidence and thus wellbeing, while increasing retention and stability, and improving function.**
- 4. The effectiveness of denture adhesives cannot compensate for significant denture deficiencies.**
- 5. Dental professionals should provide guidance and instructions to the patient on the correct application and use of the adhesive, and on removing it and cleaning the denture.**
- 6. The optimum time to advise on the use of an adhesive varies between patients. For well-fitting dentures it might occur at a review appointment, or for patients finding problems with compliance at the time of fitting or soon after.**

The Oral Health Foundation will use their authority, independence and international reach to disseminate these guidelines globally and so improve the oral and general health of denture wearers worldwide.

We also recommend that the dental community invest in further research to refine the evidence. This would help produce more specific guidelines on the use of adhesive products to improve the experience of full-denture wearers, and in particular on the frequency of application and on removal of the adhesive. We also need further insight into oral care professionals' attitudes towards recommending denture adhesives for improving the lives of their denture-wearing patients.

Research is needed to identify the optimum volume of adhesive to prevent side effects through misuse or overuse. As to when advice to patients should be given by dental professionals, we can only refer to the insights the expert community has shared with us. Therefore, more research into this particular issue may also help dental professionals to become more receptive to the recommendations on the use of adhesives by their denture-wearing patients.

In terms of biocompatibility, there is a lack of long-term (more than 6 months) *in vivo* studies to investigate the potential harmful effects of denture adhesives. This is therefore an urgent topic for research.

We thank the Global Task Force for Development of Guidelines on Use of Denture Adhesives for their time and energy in producing this white paper and guidelines for the use of denture adhesives and their benefits for oral and general health.

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○ Section 1:

Dentures: description and classification

According to the Glossary of Prosthodontic Terminology (Ed 9), a denture is an artificial substitute for missing natural teeth and adjacent tissues. They are custom-made devices and two types of removable dentures are available: complete and partial. However, there are many denture designs which, to keep dentures in place, rely on clasping to natural teeth or attaching to crowns or dental implants.

Complete (or 'full') dentures are worn by patients who have lost all their teeth in one or both jaws or 'arches'. These are called the maxillary (upper) or mandibular (lower) arches. The dentures are called 'complete' or 'full' dentures and because of the global nature of this white paper we have used both terms interchangeably throughout the document.

In removable complete dentures, the replacement teeth are attached to a base, usually made of acrylic. The dentures are supported and kept in place in the mouth by the surrounding soft and hard tissues. Saliva helps keep this seal in place.

Partial dentures are used when a patient still has one or more natural teeth. The re-placement teeth are attached to an acrylic or metal framework (mainly cobalt chrome). Metal-based dentures use teeth for support to keep them in place. Acrylic dentures use the same method as full dentures, and may also use clips or clasps. 'Overdentures' use tooth roots or dental implants to help keep them in place. Some dentures have internal attachments that attach to the adjacent crowns (on natural teeth or on implants) which help to keep them in place.

Dentures are made for people that have lost some or all of their teeth, to help:

- improve their appearance
- maintain the occlusal dimension (normal distances between their nose, mouth and chin)
- support their lips and cheeks
- improve their self-esteem and confidence
- improve mastication (chewing ability) and so help maintain healthy nutrition.

For a patient with no natural teeth, psychological factors are just as important as aesthetic or mechanical ones.

In 2015 an Omnibus survey on denture wearing was carried out by IPSOS in 19 countries (data on file with GlaxoSmithKline Consumer Healthcare). IPSOS are a market research agency and Omnibus is a type of global survey used to collect a wide range of information on various topics in a single interview.

Across the 19 countries that IPSOS researched in this survey, an average of 19% of the population wear some form of full or partial denture: 8% wear a full denture and 12% some form of partial denture. Just under half of all denture wearers (45%) are aged 40-59. The age of denture wearing tends to follow country demographics, with Mexico having 34% of denture wearers in the youngest (18 to 39) group and Japan having the greatest share (73%) of denture wearers in the oldest (aged 60 to 75+). Women (52%) are slightly more likely to wear dentures. However, in the USA (60%) and Australia (61%) men are significantly more likely to wear dentures.

In developed markets, fewer people are wearing complete dentures – the impact of preventive measures means people are keeping more of their natural teeth. In Europe, it has been shown that in some countries with low percentages of denture-wearing people, most dentures are worn by the relatively large groups of immigrants. However, recent iData research in the USA suggests that the full-denture market is stable, and, projected through to 2023, is growing slightly. This may be because of an increase in the ageing population, who were born before effective oral hygiene measures were widespread. In developing markets though, complete dentures remain of major importance.

Partial dentures are increasing in number worldwide, because it has become less acceptable to be seen with missing teeth. Despite the success of dental implants, a lot of people rely on removable partial dentures as a simpler and less-costly option for replacing lost teeth. The removable partial denture market in the USA is growing at 6% a year, due mainly to the appearance of the newer 'flexible' removable partial dentures.

For the purpose of this white paper, we focus exclusively on the usage instructions for denture adhesives in cream or paste form and the benefits of their optimal use for complete denture wearers.

○ Section 2:

Prevalence of edentulism

Over the last 20 years, edentulism has declined globally. However, this is mainly due to the trend in most high-income countries where more people are keeping their teeth. We see the opposite trend in low- and middle-income countries. Here the rate of edentulism is increasing. In the USA though, denture use is not declining but is stable (see section 1).

The World Health Organisation's Global Health Survey, carried out between 2002 and 2004, showed that edentulism is a highly prevalent condition globally. For people aged 65 and over there was an overall average prevalence of 32.9% – in individual countries this ranged from as low as 7% in Egypt, up to 72% in Iceland.¹

There was a large variation between countries that had similar income levels. This suggests that average income per head may not be the main explanation of the rate of edentulism in a given country. Other factors such as oral hygiene practices, nutritional habits, and socioeconomic inequalities have been suggested as being stronger driving factors.²

Edentulism remains a highly prevalent condition worldwide. It seems to be a more common problem in low- to middle-income countries, where the prevalence of caries and periodontal problems increases due to recent changes in dietary and lifestyle habits. But even in the USA, denture use is not declining. Removable dentures are still widespread in many areas of poverty, where edentulism continues to grow. The following factors were associated with edentulism in older age groups:

- socio-demographic factors (for example, lower education)
- lifestyle habits (for example, smoking), and
- health conditions (for example, arthritis, asthma and diabetes).³

Because of ageing and increased life expectancy all over the globe, we expect edentulism to become more widespread and to be a growing public health problem. Although in developed countries extractions of natural teeth may be in decline, in developing countries they may still be the first remedy against toothache.

Tooth loss and denture wearing can have a substantial impact on self-esteem and psychosocial wellbeing. The concept of quality of life has been developed as an objective indicator and has been widely used in medical and sociological research. Several instruments in the form of questionnaires have been validated to measure 'oral health related quality of life' (OHRQoL) in a scientific manner. Several studies confirm that a reduced number of teeth leads to a decrease in OHRQoL.⁴

Because there is an increased focus on self-esteem and social interaction for quality of life, people nowadays are more likely to go quickly to get their missing teeth replaced, rather than remaining edentulous as was readily accepted 50 years ago. For the same reason, we may see an increased use of denture adhesives by the current 'young-elderly' denture-wearing population.

In low- to middle-income countries, edentulous people will look to replace their missing teeth by getting removable full dentures. In high-income countries more people can afford the more expensive implant-supported or -retained dentures.

○ Section 3: Specifics of denture adhesives

Denture adhesives have been on the market in different forms for nearly a century. They are supplied as soluble or insoluble products. Creams, pastes, strips and powders are soluble adhesive products, while cushion pads and wafers are categorised as insoluble.

The words 'adhesive' and 'fixative' are both used equally in guidelines and in scientific research. However, because of the accepted use of the term 'denture adhesive' in the Glossary of Prosthodontics terms (9th Edition), along with the ISO 10873-2010 classification, we have chosen to use exclusively the word 'adhesive' in this paper.

- All adhesives are intended to increase the retention and stability of the denture to improve comfort for the denture wearer in daily life.

Denture adhesives may also help to maintain a seal around a denture and so reduce the accumulation of food debris underneath it. The cushioning effect of denture adhesives reduces the pressure and friction transmitted to the underlying mucosa. As a result, the appropriate use of denture adhesives may increase the patient's sense of security and satisfaction.

According to Kumar et al.⁵, the main ingredients of denture adhesives could be classified into three groups:

- adhesive agents delivering the adhesion between denture and mucosa: methyl-cellulose, hydroxyl-methyl cellulose, sodium carboxy-methyl cellulose, and synthetic polymers like acrylamides, acetic polyvinyl and polyethylene oxide
- anti-microbial agents reducing microbial growth in the adhesive: sodium tetraborate, ethanol, hexachlorophene and sodium borate, and
- other agents to help with application, storage and the delivery of freshness to the mouth: plasticizing agents; flavouring agents like oil of peppermint, oil of wintergreen, and spearmint; wetting agents, and so on.

However, more recent formulations tend to replace mineral oils and petrolatum with more biologic products like olive oil, aloe vera, myrrh, herbs and pine resin. These also have antibacterial, antifungal, anti-inflammatory and soothing properties. Active adhesive ingredients in current formulations can include combined polymethyl vinyl ether-maleic anhydride (PVM-MA) Zinc/Ca/Mg, Na – which are high-molecular-weight copolymers with adhesive and cohesive properties, and calcium salts with carboxymethylcellulose – a viscosity modifier.⁶

The basic mechanism of the action of adhesives was described in the early 1990s, but specific formula adjustments over the past decades have made them even more powerful.

Cream, strip and powder adhesives absorb water from saliva and become viscous fluids. The adhesive functions through both increased adhesion between the adhesive layer, the denture and the soft tissues and by having a greater bond within the adhesive layer compared with saliva alone. Absorbing water helps the adhesive spread between the alveolar ridge and the mucosal (fit) surface of the denture. The materials may swell by up to 50–150% by volume in the presence of water, filling the spaces between the denture and the tissues.

The properties of current adhesives depend upon a combination of both physical and chemical properties, helping the dentures stay in place and preventing their movement during chewing. Saliva increases the viscosity of the adhesive, increasing the force needed to separate the denture from the tissue surface.

Newer adhesive materials provide stronger bio-adhesive and cohesive forces. These include the free carboxyl groups formed by the hydration of adhesives such as methyl cellulose, hydroxyl methyl cellulose, sodium carboxyl-methyl cellulose or poly methyl vinyl-ether maleic anhydride. They form electrovalent bonds that produce stickiness or bio-adhesion. The increased viscosity of the adhesive creams results in their lateral spread excluding air and saliva increasing the retention.⁵

A recent *in vitro* model study, mimicking the denture gingival interface, evaluated the adhesion properties of a commercially available denture adhesive cream. It measured changes in the adhesion strength of the cream in response to specific conditions in the mouth:

- level of salivation
- pH, and
- temperature.

The results of lap shear, tensile test, and internal interactions suggested a cohesion failure, where the lowest adhesion strength was due to hyposalivation.⁷

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Zhang et al.⁸ found that the mechanical properties of commercially available denture adhesive hydrogels were critically dependent on both the formulation of the adhesives and their hydration level. Clear progression of phase separation was observed in hydrated denture adhesives as hydration increased and changed the mechanical properties of the adhesives at multiple length scales. The adhesives displaying more heterogeneous structures, which were associated with the presence of hydrophobic and organic compounds in the formulation, exhibited more variable mechanical behaviour and weaker rheological properties, but stronger adhesive properties.

Another *in vitro* comparison of the tensile bond strengths of different denture adhesives on different denture bases, showed that denture adhesives had the greatest tensile bond strength after 5 minutes. However, there were significantly different results for each of the 3 denture bases tested.⁹

The mechanical properties of adhesives are expected to be critical in defining the stability and removal of dentures from the supporting oral mucosa. A multiscale experimental mechanical approach to evaluate the performance of denture adhesive materials was used by An et al.¹⁰ The failure of denture adhesive material was found to be critically dependent on the formation of fibrillar structures within the adhesive.

An *in vitro* study by Chowdry et al.¹¹ looked at the retention ability of different commercially available adhesive materials. It found that products delivered as a paste were more resistant to dislodgement than their powder form. Since no details about the exact formulations were provided, the different ingredients involved may also have contributed to these differences.

In another *in vitro* study Jian-Min et al. measured the initial viscosity and the adhesive strength of 3 cream-type and 3 powder-type denture adhesives available on the market. The initial viscosity of all the cream-type denture adhesives was lower than the powder-type adhesives. However, after immersion in water the adhesive strength of cream-type denture adhesives then increased significantly and exceeded that of the powder-type denture adhesives. The researchers therefore concluded that dentures with cream-type denture adhesives may be easier to adjust during insertion and then are held in place more effectively.¹² Again, no details about the exact formulations were given and therefore the different ingredients involved may also have contributed to these differences.

Denture strips have been marketed with the aim of reducing mess, making the application of the adhesive easier and reducing the amount used. In a study by Kalra et al.¹³ adhesive strips were found to be less effective than paste and powder formulations. Goncalves et al.¹⁴ confirmed the results of this study and found the tested strips less effective than the cream adhesive they tested for mastication efficacy by looking at chewing cycle and chewing ability and performance. Munoz et al.¹⁵ proved in principle that all tested denture adhesives increased the retention and stability of well-fitting and well-made dentures. Denture movement – measured both objectively and subjectively – was decreased. Adhesives also increased comfort, confidence and satisfaction with dentures in conjunction with chewing hard and brittle foods. Though not significantly different, the strips had lower scores on all measures. The authors assumed that the difference between the creams and the strip product was likely to be because strips do not contain a long-acting synthetic polymer.

A literature review by Duqum et al.¹⁶ set out to clarify the evidence for the advantages and disadvantages of the use of denture adhesive in complete-denture patients. Their conclusions were straightforward:

- denture adhesives improve the retention and function of complete dentures
However, standardised guidelines are needed for the proper use, application and removal of denture adhesives
- long-term studies are needed on the biologic effects of denture adhesives on the denture-bearing mucosa
- there is a need to promote regular recall programmes for complete-denture patients.

Papadiochou et al.¹⁷ performed a systematic review of the literature up to 2014 for the effectiveness and biocompatibility of denture adhesives, and the attitudes of both patients and dental professionals toward these materials. They concluded that most clinical studies supported the fact that denture adhesives enhance the retention, stability and masticatory performance of removable dentures. However, in terms of biocompatibility, there was a lack of long-term *in vivo* studies to investigate potential harmful effects.

Allergies to denture adhesives or their components have been described, but no recent study has been found to show the exact causes of possible allergic reactions. Some products have been shown to release formaldehyde, which is cytotoxic to cell culture and fibroblasts and is a potent allergen. Also, zinc and colouring agents in a denture adhesive formula may act as an allergic stimulus. But no scientific study was found to confirm any of these assumptions. However, care should be taken when particular adhesives are used by patients suffering from these allergies. Hypersensitivity or allergy may not be recognised until the first time the adhesive is used in the mouth.

Special care is also needed with patients suffering from chronic xerostomia ('dry mouth'). These patients are often immunocompromised, and micro-organisms they are exposed to must be considered potential pathogens.¹⁸

Based on information available in Material Safety Data Sheets (MSDS), the various types of adhesives may give rise to some safety concerns, especially when denture adhesives are misused or overused. Some adhesives contain ingredients that have multiple components listed in the MSDS, and so need special attention when accidentally ingested in excessive volumes. Some are also severe eye irritants according to the MSDS. Other MSDS suggest that continual swallowing of excessive adhesives can lead to oesophageal or bowel obstruction.

Denture adhesives are available on the market in different forms. The adhesive creams seem to be the most researched and are the only ones with some consistent usage instructions. Because we found only limited documentation on powders and strips, and because their use is not as widespread as creams, we did not include these in this review. The information on insoluble adhesives such as cushion pads was also scarce, and we therefore did not include these in our review.

Many dentists still feel that if their patients use adhesives this is a poor reflection on their clinical skills and prosthetic expertise. This is despite considerable documentation recommending the use of adhesives, and bodies such as the American College of Prosthodontists providing guidelines for the correct application of denture adhesives.

Although adhesives are widely used by many denture wearers around the world, dental professionals have not been recommending their use consistently and many warn patients against using these products. Many prosthodontists see prescribing denture adhesives as a way of compensating for poor quality of prosthodontic care. In reality, denture adhesives add to patient satisfaction and comfort, and are effective even with the best quality of professional care. The use of denture adhesives is supported by a considerable body of work showing:

- improved retention and chewing ability
- reduction in instability
- improved perceived comfort while using the denture, and
- reduction or elimination of the build-up of food debris beneath the dentures.

As a result, they increase the patient's sense of security and satisfaction.

Several studies confirmed a lack of knowledge of these benefits among dental professionals. Therefore, education seems to be the biggest opportunity for changing their understanding of this category of products for the benefit of their patients.^{19, 20} In more recent research though, we have seen some more positive attitudes among dentists (and also therefore among denture wearers) towards denture adhesives.^{21, 22}

The Omnibus study from 2015 mentioned earlier, by IPSOS on behalf of GlaxoSmithKline (GSK) Consumer Healthcare, confirmed the relatively low use of denture adhesives by full-denture wearers in the 19 countries included. Again the demographics influenced the self-reported use of denture adhesives, with figures as high as 34% in the USA and very low numbers in countries like China, South Africa or Turkey.

Denture adhesives are often first used by denture wearers to compensate for reducing stability and retention as results of deteriorating fit of the denture to its supporting mucosa. Although this is common, it is not a sensible use of the products. While retention can be increased temporarily, the movement of the denture may lead to deterioration of the underlying tissues and result in longer-term problems, including mucositis and bone resorption.

It is important to note that denture adhesives are generally classified as medical devices and are regulated by regulatory bodies worldwide. Because of this product classification, there are strict requirements covering safety and effectiveness that must be kept to during the development and marketing of the products.

For example, in the EU and USA there are harmonised standards for demonstrating effectiveness and safety, as well as ongoing pharmacovigilance, that manufacturers have to keep to in order to ensure the safety of the products marketed. The rigorous product evaluation supports the safety profile of denture adhesives that are currently marketed.

Health care professionals, though, need to keep in mind the channels for reporting adverse incidents (events) for medical devices in their respective countries.

○ Section 4:

Existing guidelines for optimal use of denture adhesives

To assess the existing guidelines for the optimal use of denture adhesives, we searched the internet for recommendations or guidelines from official or recognised bodies.

Through this internet search, we have been able to collect data on official guidelines or recommendations from only a very few professional organisations and from 3 companies who manufacture these products. We used search functions and entered terms like 'denture adhesives', 'guidelines for use of denture adhesives' and 'denture adhesive recommendations'. We also searched for 'denture fixative' but no different guidelines were found. We are surprised to see that a world-renowned organisation such as the FDI (World Dental Federation) does not have any guidelines published on its website for the use of denture adhesives.

GSK Consumer Healthcare and Procter & Gamble, leaders in denture care products worldwide, promote the use of denture adhesives on their websites (mydenturecare.com and fixodent.com) and give clear guidelines for the use of adhesives. These websites are the only places where we found specific guidelines for both powder and cream adhesives.

The mydenturecare.com website, produced for the American market by GSK Consumer Healthcare, also included guidelines on the proper use of adhesive strips. The American College of Prosthodontists has guidelines on the use of cream adhesives (not powders), but these are not easy to find on their website.

The Japan Denture Care Society also used specific guidelines for powder- and cream-type denture adhesives as part of the protocol for a multi-centre, randomised controlled trial to develop Japanese denture adhesive guidelines for patients with complete dentures (The Denture Adhesive Guideline trial).²³ However, we couldn't find any reference to these guidelines in official Japanese websites available to the population. We were told that the study is complete, but no final results for it have been reported yet in the literature.

Although Colgate-Palmolive do not produce or market an adhesive, they do provide recommendations for the use of denture adhesives on their website.

The FDA (US Food and Drug Administration) and the American College of Prosthodontics are the only professional organisations that mention the possible negative side effects of overusing a denture adhesive containing zinc, and recommend using zinc-free denture adhesives. The fixodent.com website has a warning about the excessive use of zinc-containing products.

We have identified the recommendations of two individual American opinion leaders. This is because

these included specific advice for spreading the adhesive on the dentures and a recommendation for wetting the adhesive before replacing the denture in the mouth.

We found some consistency in the published guidelines on how to apply the adhesive and on how much to use. Most of the guidelines we have mentioned include a warning against excessive use (more than once a day or overfilling). Different methods are recommended for removing the adhesive at night, ranging from sunflower oil to damp kitchen roll or just scrubbing. We found no consistent recommendations on removing the adhesive from the denture before overnight storage out of the mouth.

The Japan Denture Care Society are comparing cream and powder adhesive formulations in their Denture Adhesive Guideline Trial. Participants using the cream formulation are instructed to apply the denture adhesive in the morning and use the dentures all day to have breakfast, lunch, and evening meal. Those using the powder formulation apply it in the morning to use for breakfast and lunch, then re-apply before evening meal. The control group use applications of saline solution before the respective meals. Participants were asked to remove the remaining denture adhesive immediately before applying new denture adhesive or before sleeping at night.²³

In this study, the maximum occlusal force and masticatory performance were measured immediately after application of either the powder adhesive or cream adhesive (or in the control group, saline). Final results are not yet published but we question the relevance of the different application timings in this study. However, the final publication may shed some light on this issue.

We are disappointed in the limited number of websites available for our data collection. The lack of appropriate research is most probably the cause of this low level of available guidelines on the use of denture adhesives for professionals and the public at large.

Below is a list of the guidelines we were able to find.

Country	Organisation	Guidelines
Australia	Government of South Australia – SA Health	<ul style="list-style-type: none"> • For better-fitting dentures, ask the clinic or pharmacy about a range of adhesive products that may help stabilise the denture. • Clean adhesive off daily. • Contact the dental clinic if you have concerns.
France	UFSBD	<ul style="list-style-type: none"> • Ensure your dentures are clean and dry before application of the adhesive cream. • Start with small quantities and increase step by step as you see the need for it. • Replace denture in the mouth and hold firm for a couple of seconds. • Wait 5 minutes before eating or drinking. • No need to fill the whole denture. If the adhesive overflows a lot, you have applied too much and this will not increase adherence. You can adjust the optimal amount of adhesive to guarantee a full day's comfort. If you have to re-apply the adhesive more than twice a day, your denture does not fit well anymore and you must see your dentist for a rebasing or a new denture. • Do visit your dentist at least once a year for a check up or earlier if you have pain, or sudden difficulties while eating or speaking. • If difficult to remove the adhesive from the denture, use a little kitchen oil.
Germany	BZAEK	<ul style="list-style-type: none"> • Use small quantities. A large amount of adhesive does not increase efficacy and can be dangerous if swallowed. • Do visit your dentist at least once a year for a check up. • If difficult to remove the adhesive from the denture, use sunflower oil.

Below is a list of the guidelines we were able to find.

Country	Organisation	Guidelines
Japan	Japan Denture Care Society	<p>Powder adhesive:</p> <ul style="list-style-type: none"> • Before applying the powder, dentures should be cleaned, rinsed, and left wet. • Gently squeeze or tap the bottle to dispense the powder onto the entire denture surface. • Shake off any excess powder, press the dentures into place, and hold briefly. <p>Cream-type adhesive:</p> <ul style="list-style-type: none"> • Before applying the cream, dentures should be cleaned, rinsed, and dried. • Gently squeeze the tube and place the cream in small strips or a series of dots on the denture surface. • Press dentures firmly in place and hold briefly.
Spain	topdoctors.es	<ul style="list-style-type: none"> • Dry the denture before applying an adhesive. • 4 dots of adhesive are sufficient per denture.
Switzerland	Dental Hygienists Association	<ul style="list-style-type: none"> • Use only small amounts of denture adhesive. • Every evening, the adhesive should be removed totally from denture and oral mucosa.
UK	NHS	<ul style="list-style-type: none"> • Adhesive can be removed from the denture by brushing with soap and water. • Remnants of adhesive left in the mouth may need to be removed with some damp kitchen roll or a clean damp flannel. • Follow the manufacturer's instructions and avoid using excessive amounts.

Below is a list of the guidelines we were able to find.

Country	Organisation	Guidelines
UK	Fixodent.co.uk (Proctor & Gamble)	<ul style="list-style-type: none"> • Before applying any Fixodent denture adhesive, please ensure your dentures are clean and thoroughly dry. • Start by applying Fixodent to dentures in a series of small dots or strips. Always start with a small amount and do not apply adhesive too close to the edge of your dentures. • When fitting dentures, press them firmly in place and hold. If adhesive oozes out, you have used too much. The advantage of using Fixodent denture adhesive over denture strips is you have more control over where you apply the adhesive. • You should find one application of denture adhesive a day is sufficient. If you find that you regularly need to apply more than this to keep your dentures in place, you might want to consult your dentist to address the way they fit. • Be sure to visit your dentist on a regular basis to ensure that your dentures fit properly and are in good condition. Poor denture fitting can cause considerable discomfort and may damage your mouth over time. • To remove adhesive residue from your dentures, use comfortably hot water, toothpaste and a soft-bristled toothbrush to remove any Fixodent residue from your gums, palette, tongue and mouth. Ensure that all denture adhesive is removed.
USA	American College of Prosthodontists	<ul style="list-style-type: none"> • A small amount of denture adhesive may help stabilise the denture. • Zinc-containing denture adhesives should be avoided. • Evidence regarding the effects of denture adhesives on the oral tissues when used for periods longer than six months is lacking. Thus, extended use of denture adhesives should not be considered without periodic assessment of denture quality and health of the supporting tissues by a dental professional. • Denture adhesives should be completely removed from the prosthesis and the oral cavity on a daily basis. • If increasing amounts of adhesives are required to achieve the same level of denture retention, the patient should see a dentist or dental professional.

Below is a list of the guidelines we were able to find.

Country	Organisation	Guidelines
USA	American Dental Association	<ul style="list-style-type: none"> • Denture adhesive should be used only in sufficient quantities (three or four pea-sized drops) on each denture. • Adhesive is applied to clean dentures, which are then positioned in the mouth and held in place for a few seconds, according to the manufacturer's instructions. • If increasing amounts of adhesives are required to achieve the same level of denture retention, the patient should see a dentist or dental professional to evaluate. • Patients who wear dentures should be checked annually by the dentist, prosthodontist or dental professional for maintenance of optimum denture fit and function, for evaluation for oral lesions and bone loss, and for assessment of oral health status. • Denture adhesives should be completely removed from the prosthesis and the oral cavity on a daily basis. • During denture cleaning, adhesive should be removed with gentle scrubbing to prevent contamination.
USA	DR Cagna (key opinion leader) J Massad (key opinion leader)	<ul style="list-style-type: none"> • Use small amounts of paste adhesives onto the clean and dry intaglio surface of the denture. For the maxillary denture, adhesive should be dispensed in the midpalatal region, while for the mandibular denture very small amounts can be placed in two or three locations along the ridge crest. • Once dispensed onto the dentures, the patient should evenly disperse the paste over the entire intaglio surface of the prosthesis with a clean, dry finger. This will result in a thin, even layer of adhesive. • The denture is submerged in a container of cool water to maximally hydrate the adhesive. The denture should remain submerged in water for approximately 20 to 30 seconds. • The denture is then placed in the mouth and firmly seated with finger pressure for approximately 10 seconds. • The patient should be told that the use of excessive adhesive may indicate an inadequate fit, necessitating denture relin or remake procedures.

Below is a list of the guidelines we were able to find.

Country	Organisation	Guidelines
USA	FDA	<ul style="list-style-type: none"> • Follow the instructions provided with the denture adhesive. If the product does not come with instructions or the instructions are unclear, consult with a dental professional. • Do not use more adhesive than recommended. • Understand that some denture adhesives contain zinc, and that although they are safe to use in moderation as directed, if overused, they could contribute to harmful effects. Know that there are zinc-free denture adhesives products. • Stop using the denture adhesive and consult your physician if you experience symptoms such as numbness or tingling sensations in the extremities. • Start with a small amount of adhesive – if the adhesive oozes off the denture into your mouth, you are likely using too much adhesive. • Know that a 2.4-ounce tube of denture adhesive used by a consumer with upper and lower dentures should last seven to eight weeks. Track how much denture adhesive you use by marking on a calendar when you started a new tube, and when the tube is empty. • Consider speaking to your dentist to see that your dentures fit properly. Dentures can become ill-fitting as a person's gums change over time.
World	Dentalcare.com (Proctor & Gamble)	<ul style="list-style-type: none"> • Be sure to carefully follow the directions when using a denture adhesive cream, and do not use more than directed.

Below is a list of the guidelines we were able to find.

Country	Organisation	Guidelines
World	Fixodent.com (Proctor & Gamble)	<p>Cream adhesive:</p> <ul style="list-style-type: none"> • Clean & dry dentures. • Apply adhesives in thin strips. • Insert dentures and hold briefly in place. • DO NOT use more product than directed: for full dentures, not more than 6 strips or about 3 inches total length. For Fixodent Plus Gum Care, please refer to the application instructions and diagram on the carton. If product oozes off denture in your mouth, you are using too much. • DO NOT use product more than once a day. • DO NOT use excess product for poorly fitting dentures. • Consult your dentist regularly to ensure you have properly fitting dentures. Poorly fitting dentures may impair your health. • WARNING: DO NOT use more than directed. Excessive and prolonged zinc intake is reported to be associated with serious health problems. Consult a doctor if using other products containing zinc. <p>Powder adhesive:</p> <ul style="list-style-type: none"> • Clean dentures. • Wet denture. • Apply powder in thin layer as shown on the bottle or carton. • Shake off all loose powder. • Insert Dentures and hold briefly in place. • DO NOT use more than 1/4 teaspoon. Shake off excess. If powder comes off denture in your mouth you are using too much. • DO NOT use more than once a day. With proper use this bottle should last at least 9 to 10 weeks. • DO NOT use excess powder for poorly fitting dentures. • Consult your dentist regularly to ensure you have properly fitting dentures. Poorly fitting dentures may impair your health. • WARNING: DO NOT use more than directed. Excessive and prolonged zinc intake is reported to be associated with serious health problems. Consult a doctor if using other products containing zinc.

Below is a list of the guidelines we were able to find.

Country	Organisation	Guidelines
World	Mydenturecare.com (GlaxoSmithKline Consumer Healthcare)	<p>Cream adhesive:</p> <ul style="list-style-type: none"> • Clean and dry your denture(s). • Apply Poligrip in short strips as shown on the carton; not too close to denture edges. • Rinse mouth before inserting denture(s). • Press denture(s) into place, hold firmly, and bite down for a few seconds to secure hold. <p>For removing:</p> <ol style="list-style-type: none"> 1. Swish mouth with water. 2. Slowly remove denture using a rocking motion. 3. Remove adhesive residue from denture and mouth with warm water and a soft brush. 4. Use Polident Denture Cleanser to thoroughly clean your denture(s), and then rinse with water. <p>Adhesive strips:</p> <ul style="list-style-type: none"> • Clean and dry your denture(s). • With dry hands, peel open and remove strips. • Lightly moisten one strip at a time with water. • Place strips on your dentures, not too close to the edges. Do not overlap strips. (Cut strips if needed). • Rinse mouth with water before inserting dentures. • Press dentures in place, hold firmly and bite down. <p>For removing:</p> <ol style="list-style-type: none"> 1. Swish mouth with water. 2. Slowly remove dentures using a rocking motion. 3. Remove adhesive residue from your denture(s) and mouth with a soft moist cloth. 4. Use Polident Denture Cleanser to thoroughly clean your denture(s).

Below is a list of the guidelines we were able to find.

Country	Organisation	Guidelines
		<p>Adhesive powder:</p> <ul style="list-style-type: none"> ● Clean your denture(s) thoroughly and leave wet. ● Spray or shake powder very lightly and evenly onto denture surfaces coming into contact with gums or roof of mouth. ● Thoroughly shake off any excess powder. ● Press your denture(s) in place, hold firmly, and bite down for a few seconds to secure hold. <p>For removing:</p> <ol style="list-style-type: none"> 5. Swish mouth with water. 6. Slowly remove dentures using a rocking motion. 7. Wipe adhesive residue from gums and dentures with a soft, moist cloth. 8. Use Polident Denture Cleanser to thoroughly clean your dentures.
World	Colgate (www.colgate.com)	<ul style="list-style-type: none"> ● Adhesive should be used sparingly and applied to well-cleaned dentures. ● A good routine to follow is: Rinse your denture, apply the recommended amount of adhesive to the denture and immediately place in your mouth. ● Once the denture is in place, the adhesive should last most of the day. ● An upper denture is less likely to loosen from normal eating, but a lower denture can loosen more easily from drinking and eating. In this case, you may need to reapply adhesive during the day. ● If you notice your dentures no longer fit properly, visit your dentist. Although they may just need to be relined or replaced, some instances suggest an adhesive is the only recommendation to make you feel confident about your smile.

○ Section 5:

Existing professional recommendations for use of denture adhesives

In spite of the widespread use of denture adhesives by denture wearers around the world, not many dentists or prosthodontists recommend denture adhesives in daily practice. This is because of the stereotype view that dentures should be inherently stable, without the aid of adhesives. Many dental professionals see recommending denture adhesives to patients as being a way to compensate for any defects during the manufacture of the denture. They feel it reflects their inability to 'fix' the denture. Interestingly, this seems to run against the guidance of relevant professional groups in some countries.

All dentists should be capable of delivering well-fitting dentures. Although their aim is to achieve stable, retentive, and comfortable dentures for their patients, they may not routinely recommend denture adhesives. Such recommendations that there are seem to be for specific situations and are just an 'option' for when other solutions fail. Denture adhesives therefore are seen by dental professionals as relatively complicated to recommend and use.

To assess the existing recommendations for the use of denture adhesives, we searched the internet for recommendations by officially recognised bodies and oral care companies (see section 4). We used search functions and entered terms like "denture adhesives", "recommendations for use of denture adhesives" and "denture adhesive recommendations".

During our search we found that most dental organisations recommend denture adhesives only in particular cases – such as for patients with dry mouth syndrome, or while they were getting used to new dentures, or as an emergency solution before new dentures are made. These organisations advise that for atrophic arches, denture adhesives may be the only guarantee to improve the stability of dentures.

Oral care companies market denture adhesives as an appropriate aid for improving the retention and stability of well-fitting dentures, and so claim increased security, confidence and comfort for patients using a denture adhesive. They do not recommend the use of a denture adhesive for ill-fitting dentures. A recent additional benefit advocated by denture adhesive manufacturers is that denture adhesives may reduce food trapping under dentures, something that can be at the least unpleasant and sometimes painful for patients.

Here is we found by way of recommendations for the use of denture adhesives.

Country	Organisation	Guidelines
France	UFSBD	<p>A denture adhesive is an aid during the adaptation phase. By fixing the denture, it improves stability and therefore limits micro-movements and thus problem zones. Therefore do not hesitate to use an adhesive. It provides:</p> <ul style="list-style-type: none"> • extra-secure adhesion • shock damping and therefore takes care of your soft tissues • a barrier to food particles. Food trapping can be one of the major issues while wearing dentures.
The Netherlands	Ivoren Kruis	<ul style="list-style-type: none"> • There are all kinds of adhesive pastes and powders on the market to give a denture more stability. • These resources are all emergency solutions. • The cause of the problem is not really taken away.
Germany	BZAEK	<p>Adhesive cream can be recommended to patients who suffer from oral dryness to increase fit and comfort.</p>
Japan	Japan Prosthetic Society (2009)	<p>Many dentists in Japan are hesitant to acknowledge denture adhesives in daily practice because of the stereotype that dentures should be inherently stable, without the aid of adhesives.</p>
Spain	topdoctors.es	<ul style="list-style-type: none"> • Use of denture adhesives can help in some cases. • Most patients have sufficient mucosa and undercuts and do not need the support of an adhesive. • In case of atrophic jaws, adhesives can help retention through better sealing between dentures and gums. • After 1 or 2 years a relining of the dentures may be needed because of further atrophy of the underlying bone. It is not recommended to substitute the relining by a continuous use of denture adhesives. It only gives a sensation of false comfort. • Dental adhesives can be considered as an aid when the gums are atrophic and there is only little support, but they will never replace a good fit of them.

Here is we found by way of recommendations for the use of denture adhesives.

Country	Organisation	Guidelines
UK	NHS	<ul style="list-style-type: none"> • If your dentures fit properly, you shouldn't necessarily need to use denture fixative (adhesive). • If your jawbone has shrunk significantly, adhesive may be the only way to help retain your dentures. • At first, some people feel more confident with their dentures if they use adhesive.
UK	Oral Health Foundation	<ul style="list-style-type: none"> • Dentures are custom made to fit your mouth and you shouldn't need a denture fixative. • However, some people prefer to use a fixative to give them extra confidence or if their dentures start to become loose before they have them replaced.
UK	Fixodent.co.uk (Proctor & Gamble)	<ul style="list-style-type: none"> • Dentures require muscle power to keep them in place. The muscles in your lips, cheeks and tongue need to learn to co-ordinate and work together to hold your dentures in position. • Fixodent denture adhesive creams are specially formulated to keep dentures firmly and comfortably in place with the minimum of fuss. • Fixodent denture adhesive cream doesn't just stop dentures slipping, it is also ideal for reducing sore spots and irritation caused by dentures that rub. If pain or soreness persist, visit your dentist. • Without a proper seal, troublesome food and drink particles have a habit of getting behind dentures, where they decay and cause bad breath. Fixodent denture adhesive incorporates 'food seal' technology. This stops these causes of odours, whilst an anti-bacterial action reduces the spread of any bacteria.
USA	American College of Prosthodontists	<ul style="list-style-type: none"> • Denture adhesives can improve retention and stability in well-fitting dentures. • Adhesives help seal out the accumulation of food particles beneath the dentures. • In a QOL study patient ratings showed that denture adhesives may improve the denture wearer's perception in retention, stability and QOL. • There is insufficient evidence that adhesives improve masticatory function.

Here is we found by way of recommendations for the use of denture adhesives.

Country	Organisation	Guidelines
USA	American Dental Association	<ul style="list-style-type: none"> • A film of saliva typically helps hold dentures in place. Denture adhesives may be used if the salivary glands do not produce a sufficient amount of saliva. • Denture adhesives are not a remedy for ill-fitting dentures. A denture that fits poorly (ie, feels loose or causes discomfort) may need to be relined or replaced as it can contribute to the development of mouth sores.
USA	Dr Cagna (key opinion leader) Dr Massad (key opinion leader)	<ul style="list-style-type: none"> • A denture adhesive augments retention and stability of conventional complete dentures. • Adhesives are indicated for routine use when appropriately fabricated complete dentures do not satisfy stability and retention expectations of the patient. • Denture adhesives may prove psychologically beneficial, when the patient requires supplemental retention and stability, particularly during times of public interaction. • Denture adhesives are not indicated to provide retention for ill-fitting prostheses. • Denture adhesives have been shown to reduce mucosal irritation, reduce food debris accumulation beneath the denture base, improve chewing efficiency, increase bite force, improve functional load distribution across the denture-bearing tissues, and facilitate the psychological wellbeing of the patient. • For patients with xerostomia, the use of a well-hydrated denture adhesive provides a cushioning or lubricating effect, reducing frictional irritation.
World	Dentalcare.com (Proctor & Gamble)	<ul style="list-style-type: none"> • Denture adhesives create a thin, glue-like film between your dentures and gums to help seal out food and secure your dentures in place. • About 15 days after you start wearing dentures, or after your gums are healed completely, consider using a denture adhesive cream. • Denture adhesives can help you eat, drink, laugh, and talk with confidence.

Here is we found by way of recommendations for the use of denture adhesives.

Country	Organisation	Guidelines
World	mydenturecare.com (GlaxoSmithKline Consumer Healthcare)	<ul style="list-style-type: none"> • Denture adhesives can make your life easier by offering stability and comfort so you can enjoy laughing with friends and continue to eat the foods you love. • Denture adhesive can make your denture feel a lot more secure. • Denture adhesive forms a seal to help prevent food particles getting stuck between your dentures and gums to help you enjoy your meals. • Denture adhesives can keep you feeling confident in social situations or when getting close with loved ones. • An adhesive can help ease any concerns you may have about denture movement while laughing and talking. • An adhesive may help you to adapt to your new dentures and give you more confidence from the outset, easing any worries you may have of it falling out. • An adhesive shouldn't be used as a substitute for a well-fitting denture. Over time, dentures can become loose, and may need repairing or replacing.
World	Colgate	<ul style="list-style-type: none"> • Denture adhesive can improve the fit of full or partial dentures, but it isn't always necessary. Well-fitting dentures usually do not need help staying in, but many people still use them for a sense of security. • If your denture is fitted immediately after your teeth are removed, you may need to use a denture adhesive for a limited time. If your denture feels fine and is properly maintained, however, it may be unnecessary.

Here is we found by way of recommendations for the use of denture adhesives.

Country	Organisation	Guidelines
World	dentaid.com (dentaid)	<ul style="list-style-type: none"> • Less chewing force, especially with hard foods, may cause dissatisfaction, take the pleasure away from eating and cause nutritional problems that affect overall health. This is why it is advisable to use a bonding adhesive, which provides comfort and confidence. • Using a denture adhesive improves the stability of dentures, increases retention and biting strength, creates a bond between dentures and gums, preventing dentures from moving or detaching. • One of the disadvantages of dentures, if not properly adjusted, is that food debris can become trapped between them and the gums, causing discomfort while favouring the growth of bacteria that may cause bad breath. • They may also bring about psychological problems caused by the insecurity related to talking and showing dentures.

○ Section 6:

Effectiveness of denture adhesives with well-fitting dentures

1. Retention

Grasso et al.²⁴ measured denture movements using an alternating magnetic field tracking device, that determined the position of magnetic receiver coils relative to a transmitter coil positioned over the head (Move Track). Measurements of denture movements were made at baseline (no adhesive) and at 0, 2, 4 hours post-adhesive application for standardized chewing and biting.

The results of the measurements showed that:

- mandibular (lower) denture movements, both with and without an adhesive, were significantly greater than maxillary (upper) denture movements
- the adhesive significantly reduced movement of the maxillary and mandibular dentures during both chewing and biting, and
- the improvement happened immediately after the adhesive was applied and was maintained for the four hours of follow-up.

Polyzois et al.²⁵ investigated the effect of four commercially available denture adhesives on the incisal and premolar dislodgement forces of maxillary complete dentures. They compared the measured incisal forces for differences and concluded that denture adhesives increased the denture dislodgement forces, but with differences among them. The two devices they used (electronic and disposable) did not have high agreement, but each one alone was useful in estimating dislodgement forces in clinical practice and research. The disposable device was also used in other studies where significant increases in denture dislodgement forces were reported, confirming that denture adhesives improve the retention of complete maxillary dentures and satisfaction among patients.^{26, 27, 28, 29}

A more recent study by Shamsolketabj et al.³⁰ looked specifically at the impact of denture adhesives on 3 groups of denture-wearing patients with different levels of bone resorption of the residual ridges. Retention, chewing, talking, self-confidence and the efficiency of the dentures were improved in all patients. No statistical significant differences in these parameters were observed between the 3 groups.

However, the adaptation period may affect the occlusal forces for dislodgement of new dentures. Even so, overall better denture retention was found when an adhesive was used compared with non-use.³¹

2. Stability

Some of the retention studies measured stability but used measures such as mean chewing rate, denture movement, wobbling or dislodgement. In our opinion, these measures refer to stability rather than retention only.

Rendell et al.³² carried out a controlled study to decide if a reduction in mandibular denture movement and improved chewing function could be seen in edentulous patients using adhesives. They recorded mandibular movements using a multichannel magnetometer tracking system while the subjects chewed standardised pieces of dried apricots and fresh white bread. They made recordings for the test subjects, firstly without the use of denture adhesive, and then at 0, 2 and 4 hours after a denture adhesive was applied to the mandibular denture. The control group was made up of patients who did not have their natural teeth. Statistically significant increases in the mean chewing rates were reported for the test group after the denture adhesive was applied – at all time points and for both foods. None of the with-adhesive rates were significantly different from the control group's rate. These findings show that using a denture adhesive promotes a faster and more natural rate of chewing.

Munoz et al.¹⁵ also confirmed in their study that denture adhesives significantly improved the retention and stability of well-fitting dentures. Subjects had significantly fewer dislodgements while eating an apple after adhesive was applied to dentures. Significant increases in subjective ratings of confidence and comfort, as well as decreases in denture wobble, were associated with the use of adhesive. There was significant improvement in satisfaction ratings for cream adhesives.

Recently some newer methods, like electromagnetic articulography, have been used to measure micromovements of dentures during different chewing challenges. These confirmed that the use of adhesives was associated with statistically significant reductions in denture micromovements for hard, sticky, and tough foods as measured with both distance and threshold endpoints.³³

3. Masticatory (chewing) performance

To examine the effects of a denture adhesive on masticatory functions for complete-denture wearers, the following have been suggested as possible measurements for performance:

- maximum biting forces
- masticatory performance, and
- electromyography of the masseter muscle during mastication.

A study by Fujimori et al.³⁴ considered the duration of both the chewing burst and chewing cycle. In this research, the use of the denture adhesive increased maximum biting force and provided rhythmic masseter muscle activity during mastication for both good and poor denture-bearing tissues. Masticatory performance was improved and the duration of the chewing burst was decreased only for the 'poor' group. It was therefore concluded that the effect of the denture adhesive on masticatory functions was positive for both groups, but was more significant for denture wearers with poor denture-bearing tissues than those with good denture-bearing tissues.

De Oliveira et al.³⁵ assessed the masticatory performance immediately after the use of a denture adhesive by means of the sieve method, in which participants were instructed to deliberately chew 5 almonds for 20 chewing strokes. Masticatory performance was calculated by the weight of crushed material that passed through the sieves. The use of denture adhesive improved the masticatory performance of conventional complete-denture wearers.

Using other methods for measuring masticatory performance provided similar results and it was concluded that denture adhesives improve mastication by shortening the chewing cycle and by enhancing chewing ability and performance.³⁶ A crossover randomised clinical trial by Marin et al.³⁷ used kinesiographic measures to confirm that the use of denture adhesives in complete-denture wearers altered mandible movements. There were increases in vertical movements during chewing and less intrusion of maxillary complete dentures.

4. Food trapping

A recognised secondary benefit of denture adhesives in patients with complete dentures is their ability to act as a barrier to help prevent the migration and accumulation of food particles under the dentures.

In a study by Munoz et al.³⁸, food entrapment was quantitatively measured by collecting and weighing residue from beneath the dentures after users had chewed and swallowed 32 grams of a peanut test meal. Without adhesive, the quantitative amount of peanut residue entrapped beneath the mandibular denture was more than double that under the maxillary denture.

In a more recent randomised, crossover, double-blind clinical trial by Torres-Sanchez et al.³⁹ VAS scales (1-10) were used. According to the results obtained, the authors concluded that, with the logical limitations of this study, the denture adhesives used in the study significantly improved the satisfaction of edentulous patients. This was because a better retention stability was achieved and also because there was less accumulation of food substitute between the denture and mucosa, when compared with not using denture adhesives.

○ Section 7:

Health challenges with the use/ misuse of denture adhesives

Millions of denture wearers regularly use denture adhesives to enhance their denture retention, stability and function. The proper use of a denture adhesive can provide both dentist and patient with a way of securing the denture and can complement the practitioner's best efforts to achieve a well-fitting denture.

Denture adhesives usually contain one or more ingredients that swell and become viscous and sticky as they absorb water. Many adhesives also contain colouring, flavouring, wetting and preserving agents. Some of these compounds could potentially cause or contribute to adverse reactions among users of denture adhesives. As a principle therefore, denture adhesives should:

- have neutral or slightly alkaline pH
- have minimal toxicity to the oral mucosa
- not promote microbial growth
- be odourless and tasteless, and
- retain the adhesive properties for 12 to 16 hours before reapplication is needed.

Neither the possible side effects on the oral mucosa of regular adhesive use or general health issues because of overuse and possible ingestion of denture adhesive materials have been fully researched and reported.

Denture patients should be instructed in their proper use and cautioned against misuse.

1. Cytotoxic effects

Examining the dental literature on the cytotoxic or irritation potential of denture adhesives revealed only a few recent studies. Ekstrand et al.⁴⁰ in 1993 investigated the cytotoxic effects, microbial contamination and formaldehyde content of 19 commercially available denture adhesives. They reported that all the materials were cytotoxic to mouse fibroblast cells and some had microbial contamination. Other researchers have reported some level of cytotoxicity for certain adhesives, but none of the studies addressed the irritation potential of the denture adhesives. Some of the tested products may no longer be on the market and others may have changed formulation since then.

Al et al.⁴¹ in 2005 published a study that aimed to examine the in vitro biocompatibility of 5 denture adhesives. None of the tested denture adhesives showed a noteworthy acute irritation as evaluated by the HET-CAM method. None of the tested denture adhesives induced cytotoxicity in the filter diffusion test. Only one of six adhesive types evaluated induced severe cytotoxic reactions. However, the authors did raise concerns that adhesives may contribute to mucosal inflammation in denture wearers, since they are commonly used throughout the day.

A recent study by Soares et al.⁴² tested 3 different adhesives with older and younger donors and considered all the materials to be non-cytotoxic, although these products affected cytokine and growth factor release.

2. Toxicity of zinc-containing adhesives

The most serious health issue so far reported as a result of long-term and excessive use of denture adhesives is potential neurotoxicity related to the presence of zinc in certain denture adhesives. Zinc is a mineral that is an essential ingredient for good health. It is found in protein-rich foods such as shellfish, beef, chicken and nuts, as well as in some dietary supplements. However, an excess of zinc in the body can lead to health problems such as nerve damage that only appears slowly and over a long period of time.

Two published case-series studies identified patients experiencing progressive neurological symptoms following extended overuse of zinc-containing adhesives. This misuse of the adhesives by the patients resulted in hypocupremia and hyperzincemia with resultant neurological symptoms. However, no attempt was made in these studies to assess whether the existing dentures had acceptable fit, retention, occlusion and stability, or whether the patients affected were correctly using the zinc-containing adhesives. Both sets of authors identified denture adhesives as the sole source of the neurologic disease.

Another separate study by Hedera et al.⁴³ looked at the different sources of zinc intake among patients suffering from progressive myelopolyneuropathy and who had unexplained hypocupremia with hyperzincemia. All had a history of ill-fitting dentures which needed large amounts of denture cream, resulting in significant zinc exposure. Their copper and zinc normalised after they stopped using zinc-containing denture adhesive, further confirming that this is the source of high zinc. Inappropriate use of denture adhesives therefore appeared to be the sole source of excessive zinc in these patients.

The FDA (US Food and Drug Administration) has not found conclusive evidence that these problems result from using zinc-containing denture adhesive as instructed in the product labelling. The FDA warns of overuse of zinc-containing denture adhesives, especially when combined with dietary supplements that contain zinc and other sources of zinc that together can contribute to an excess of zinc in the body.

In 2010, a review of the existing literature that documents the serious adverse systemic effects of prolonged, excessive zinc ingestion from the overuse of denture adhesives was presented. Epidemiologic studies revealed the source of excessive zinc intake to be from overuse of denture adhesives. Therefore denture patients must be advised of the risks of prolonged overuse of denture adhesives.⁴⁴

3. Microbial growth

Denture adhesives often include antimicrobial agents such as hexachlorophene, sodium tetra borate, methyl salicylate and sodium borate. Therefore, the long-term use of adhesives may affect the oral microflora by selectively supporting the growth of some micro-organisms and inhibiting others. A study by Özkan et al.⁴⁵ tested this hypothesis. It compared the presence of *Candida Albicans* and α -haemolytic streptococci in the saliva and on the palate and dentures of a group not using a denture adhesive, and another group using a denture adhesive. Comparisons were made at the start of the study, and after 1 and 2 months. No statistically significant difference was found at all time intervals. They therefore concluded that prolonged use of the denture adhesive (tested up to 2 months) did not lead to an increase in micro-organisms of the oral flora.

Similar results were recorded by Leite et al.⁴⁶ in a study that evaluated the effect of a denture adhesive on the formation of biofilm on the internal surface of complete dentures and the palatal mucosa of denture wearers. Similar colony counts were found with or without the use of adhesive for both the mucosa and internal surfaces of maxillary dentures after 15 days, irrespective of the culture medium. They therefore concluded that the use of a denture adhesive did not alter the colony counts of micro-organisms on the palatal mucosa and maxillary dentures of complete-denture wearers.

In vivo trials have found few negative effects attributed to adhesive use. In a cross-sectional study of 12 maxillary and complete-denture wearers, Kim et al.⁴⁷ found no statistical difference between the test (adhesive use) group and control (no adhesive) group in terms of *Candida* species counts, either in the saliva or on the maxillary denture. In a similar assessment of 24 denture-wearing patients, Oliveira et al.⁴⁸ compared the number of colony-forming units (CFUs) and *Candida* species in saliva samples. These were collected when dentures were first put in, and then at 7-day and 14-day intervals from patients using an adhesive denture strip. There was no statistical difference between the group and control group at the 2-week analysis.

Borole et al.⁴⁹ also evaluated the effects of different denture adhesives on the growth of *Candida Albicans* in especially vulnerable diabetic patients. They found an overall increase in the number of CFU/ml of *Candida* species following the use of denture adhesives in diabetic and non-diabetic groups after 14 days of using a denture adhesive. However, the mean percentage increase in CFU/ml was not of any clinical significance.

No clinical study has demonstrated that denture adhesives promote an alteration of the oral microbial population. However, as there are no longitudinal trials of longer than 6 months on the continual use of denture adhesives by the same patients, the effects of long-term use of adhesives on oral tissues are currently unknown. Some authors therefore recommend caution when prescribing adhesives to immune-compromised patients.

The antimicrobial and antifungal properties of denture adhesives have been confirmed in several *in vitro* studies. Recently Rajaram et al.⁵⁰ found that the 3 forms of commercially available denture adhesives they tested showed an antifungal effect. Polyzois et al.⁵¹ investigated the antimicrobial activity of 3 commercially available denture adhesives on some oral-malodour-related microbes. They found that, under the conditions of their *in vitro* study, all the tested denture adhesives showed antimicrobial action. However, there were differences among them. Myatt et al.⁵² demonstrated the ability of a marketed denture adhesive to deliver superior second-person breath benefits compared to those with no denture adhesive. The results indicate that this particular denture adhesive provides the denture wearer with a noticeable improvement in breath.

In summary, although potential side effects exist there is no research available that definitively associates their long-term use with harm. In common with any product there is a balance between the benefit from the product and the potential for a side effect, however small that is. Though no studies confirming long-term safety are available, no reports on any safety issue with the long-term correct use of denture adhesives are found in the literature. Based on present evidence, we may assume that denture adhesives are safe, when used in line with the manufacturer's instructions. Nevertheless, a recommendation for the use of a denture adhesive should be on perceived need.

4. Application and removal of adhesives

We couldn't find any reference to studies that evaluated different ways to apply denture adhesives or for the most appropriate placement of the adhesive on the denture. There are also no studies reported to our knowledge that have evaluated the patient's ability to correctly apply denture adhesives on the surface of the denture, so that the denture adhesive works the most efficiently.

Disadvantages of denture adhesives also include the difficulty of removing them from the oral mucosa and the denture undersurface. One possible reason for this is that commercially available denture adhesives were developed to increase long-term viscosity. In light of the potential health challenges from using adhesives over the long term it must be clear that they need to be completely removed from the oral mucosa after some time and definitely before going to bed.

Some studies have evaluated the patient's ability to effectively remove the adhesive. Harada-Hada et al.⁵³ tested denture cleaners for the removal of denture adhesives. They found that cream adhesives were removed more completely after soaking in most denture cleaners than after soaking in water. The addition of Cellulase to the denture cleaner also may be promising.⁵⁴

A recent study by Almeida et al.⁵⁵ was presented at the European Congress on Computational Methods in Applied Sciences and Engineering in October 2017. It evaluated, using image processing, the recommended adhesive removal techniques produced by the adhesive manufacturers. They concluded, taking into account the in vitro studies' limitations, that none of the techniques recommended by the manufacturers would remove the adhesive completely. Water brushing gave less efficient results. Soaking in an alkaline peroxide solution, followed by brushing, gave much better results. Even so, removal was incomplete. There must be more studies in this field to achieve better removing methods and results.

Finally, there have also been no long-term studies to investigate the potential effects of adhesive build-up on hard or soft oral tissues, if the patient fails to remove the adhesive completely.

5. Oral cancer

Although this topic is not directly related to the use of denture adhesives, we want to highlight the possible link between ill-fitting dentures and the theoretical risk of developing oral cancer. We do this because using denture adhesives with ill-fitting dentures may lead to a false sense of adequate fitting. A study by Rotundo et al.⁵⁶ evaluated a small sample of 71 new cases of oral carcinoma. When they compared them to 240 control patients without oral cancer, they found a statistically significant relative risk of 3.98 of an association between ill-fitting dentures and oral carcinoma. In the mandibular arch, the relative risk was 6.39 (the relative risk for the control group is assumed to be 1.0). Also, Manoharan et al.⁵⁷ carried out a meta-analysis to see if there was a relationship between dentures and the development of oral cancer. They found that the use of ill-fitting dentures substantially increased this risk (odds ratio of 3.90). Using adhesives may lead to patients not seeing a dental professional regularly, allowing oral cancer to develop unchecked.

○ Section 8:

Health opportunities associated with the use of denture adhesives

1. Denture performance

The two important features for a successful complete-denture therapy are:

- technical excellence during the manufacture of the prosthesis, and
- effective management of the patient.

Even the most accomplished practitioners find it difficult to satisfy the patient's expectations for stability and retention of the denture. Therefore it is often considered appropriate to recommend a denture adhesive for these patients.

'Best-fitting' denture performance is limited by patients' oral anatomy as a result of a small lower jaw or flat alveolar ridges/small basal seat. The term 'best-fitting dentures' describes dentures that have been properly fitted by a dental health professional and provide the best fit possible within the constraints of an individual patient. In some cases, restricted anatomy may lead to poorer denture retention and stability, chewing ability and satisfaction.

Denture adhesives can maintain the performance of a best-fitting denture. However, it is important to distinguish best-fitting dentures from dentures that fit poorly. Denture adhesives should never be used to compensate for dentures that fit poorly. Most existing scientific evidence shows that retention and stability are increased significantly after the application of denture adhesives.

2. Psychological confidence

It has been reported that denture adhesives may also raise psychological confidence for patients, especially during social interactions, as they increase retention and stability. And it also has been shown that denture adhesives can lead to an increase in mastication rate and therefore a decrease in the duration of the masticatory cycle (see section 6).

Patients may find the transition to dentures traumatic. Many patients often have unrealistic expectations of dentures, complaining about food trapped under the prosthesis or small sore spots arising from slight movements of the denture in the mouth. These patients may benefit from denture adhesives that limit movement and food trapping. Food trapping under a denture is common.

Evidence suggests that up to 86% of people complain about food getting trapped under their dentures (GlaxoSmithKline Consumer Healthcare data on file). Foods such as peanuts can be particularly troublesome. Food debris squashed between the denture base and the mucosa feels uncomfortable and may encourage bacteria to grow which could cause bad breath.

Sealing the dentures to the gums can help protect against food getting trapped. Munoz-Viveros et al.³⁸ quantitatively assessed the ability of denture adhesives to reduce food trapping during eating for patients with well-fitting dentures. They reported a significant reduction of food trapping for both mandibular and maxillary dentures when eating a peanut test meal. They concluded that denture adhesives can help keep dentures secure throughout the day and help seal out food particles.

Papadiochou et al.¹⁷ carried out a systematic review of the literature up to 2014 on the effectiveness of denture adhesives, as well as on the attitudes of both patients and dental professionals toward these materials. They concluded that most clinical studies supported the fact that denture adhesives enhance the retention, stability and masticatory performance of a removable prosthesis.

We can conclude that denture adhesives add to retention and so improve chewing ability, reduce any instability, provide comfort and eliminate the accumulation of food debris beneath the dentures. As a result, they increase the patient's sense of security and satisfaction.

3. Oral health and general health

There is more and more evidence that oral health cannot be considered in isolation from the rest of the body. Epidemiological studies show that oral health is linked to physical, mental, and social wellbeing.

Kimura et al.⁶⁶ showed that reported chewing difficulties in older adults are associated with the activities of daily living, cognitive status and depression. The association between impaired chewing function and cognition was also shown by Teixeira et al.⁵⁸

Compared with cross-sectional studies on the relationship between oral health and general health, there have been fewer longitudinal studies. Yamamoto et al.⁵⁹ showed that oral health problems predicted the development of depression.

Tran et al.⁶⁰ examined the predictive ability from oral health to general health and vice versa using a Belgian registry. Through a longitudinal study, this research explored the relationship between oral health and general health. It compared oral health indicators (non-intact teeth, chewing difficulty, and dry mouth) and general health indicators that summarised the functional, cognitive and mental conditions of the subjects, and their stability over time. The participants were recorded at baseline and then every six months afterwards. The number of repeated measurements varied among subjects – ranging from one to nine follow-up occasions – and this definitely is a limitation of the present study. The research showed that individuals who had poorer oral health had a higher risk of suffering from poor general health. The percentages of correct or close prediction for general health indicators from oral health indicators are high, being around 80% for all general health indicators. Also, having a poor oral health status was predictive of poor general health status at following assessments.

Bartlett et al.⁶¹ carried out a small pilot study comparing dietary intake for complete-denture wearers who had a targeted dietary intervention and who also used a denture adhesive. They compared dietary intakes in the same group prior to the interventions with those reported 30 days afterwards. They showed significantly greater intakes in fruit, vegetables, saturated fat and Vitamin C. There was a statistically significant improvement over the 30-day treatment period in subjects' ability as measured by using OHIP Edent (Oral Health Impact Profile with edentulous people) scores to bite and chew a range of foods. The results of this pilot study suggest that there is limited evidence that people with complete dentures who use denture adhesives and are prescribed a specific diet will eat a healthier diet.

Nicolas et al.⁶² assessed the oral health-related quality of life of complete-denture wearers who used a denture adhesive over a 6-month period. Significant improvements were observed in the scores obtained for each field of GOHAI (function, pain, discomfort, psychosocial). However, even after using the denture adhesive, no statistically significant change in masticatory parameters was found. These results show that using a denture adhesive may improve subjects' ability to manage conventional dentures and enhance their oral health quality of life. But a larger, prospective, multicentre study is needed to confirm these results.

Polyzois et al.⁶³ in another study assessed differences on the Oral Health Implant Profile-14 (OHIP-14) scale over a month and determined association with gender, supporting tissues (KIS) and denture base (KID) among patients wearing complete dentures and using denture adhesives. A decrease of OHIP-14 score just 15 days after the use of an adhesive in both dentures shows that this short period is capable of revealing the effect of denture adhesives on OHIP-14. This study shows that there is a definite improvement in 2 weeks after using an adhesive. This implies that adhesives do help the improvement of OHQoL in patients with new complete dentures and may be used to shorten the adaptation period for new dentures. The clinical relevance supported by the findings of the study was that the use of an adhesive for a short period by denture wearers, regardless of gender, could improve denture adaptation and satisfaction. The study shows that OHIP-14 scores, when applied to new denture wearers, decrease if denture adhesives are used for at least 15 days. A low Kapur Index for denture-supporting tissues and high Kapur Index for denture-base quality contribute to this trend.

4. Xerostomia

A major health problem, quite often seen with older people or patients under multi-medication, is xerostomia or dry mouth. Lack of saliva can limit the retentive capacity of a denture through changes in surface tension, viscosity and border seal.

Some experts believe that with these patients, the use of a denture adhesive, combined with artificial saliva, may enhance retention of the denture and improve the comfort for the patient. Bogucki⁶⁴ recently published a study confirming the relatively small but positive impact of denture adhesives on average retention forces in complete maxillary denture patients with xerostomia. In another study Bogucki et al.⁶⁵ presented the subjective results of a HRQL questionnaire: 36% of subjects were satisfied with the retention of their maxillary denture with the use of the adhesive, and 18% were very satisfied.

Recent gel forms of denture adhesives seem to behave as if they carry a reservoir of water to compensate for a lack of saliva. But no evidence for a better performance with xerostomia patients has been reported yet. A subjective feeling of 'increased saliva thickness' and a reduction of the palatal minor salivary gland flow rates among complete maxillary denture wearers was recently reported by Demeter et al.⁶⁶

In vitro studies done in Japan evaluated gel-type oral moisturisers with commercially available denture adhesives. They concluded that the moisturisers had the same level of viscosity and provided the same retention strength as the denture adhesives. This suggested that a gel-type oral moisturiser may serve as a denture adhesive.^{67, 68, 69} The results suggest that 'stability', an 'uncomfortable feeling', and a 'dry feeling' were the main reasons for patients choosing either the denture adhesive or an oral moisturiser.⁷⁰

Usually symptoms of xerostomia are treated with humectants and it seems that no other solutions are available. However, it was reported that Chinese herbal medicines may have a positive effect. Therefore their use has often been recommended to help patients with xerostomia. However, their action compared to denture adhesives was unknown and only recently studied by Nacai et al.⁷¹ This study showed that adding herbal medicine components does not affect the initial viscosity or adhesive strength of the adhesive and does not cause cytotoxicity in fibroblast cells. Therefore it may be feasible to develop cream-form denture adhesives containing herbal medicines. This may be a possible combination to help improve the performance of denture adhesives for xerostomia patients.

However, the exact working mechanism of denture adhesives in patients with dry mouth remains unknown. It could very well be that more of the limited saliva flow is used to keep dentures in place, and that the adhesive absorbs saliva initially but then reaches a balanced state and allows more saliva to remain in the mouth than would otherwise. But it could also be that adhesives simply absorb saliva and make the xerostomia worse. At best, the evidence for the use of denture adhesives with dry mouths is limited. Their use by patients should be assessed case by case.

○ Section 9:

Recommendations for the optimal use of denture adhesives

Although it has been proven that denture adhesives improve the retention and function of complete dentures and lead to superior satisfaction with full-denture wearers, most edentulous people do not use adhesives.

Polyzois and de Baat compared the differences in the use of, and attitudes towards, denture adhesives in Greece and the Netherlands. They found similar attitudes but quite different levels of knowledge of adhesives and the need for their use.⁷³ In the Netherlands, all the participants knew that denture adhesives existed: in Greece, 27% answered that they didn't know of their existence. In the Netherlands, 90% of the denture wearers surveyed reported that they did not need denture adhesive. In Greece, only 70% reported that they could manage their dentures well without denture adhesive.

In Turkey, Ozcan et al.⁷⁴ used a questionnaire to investigate the approach and attitudes of complete-denture wearers to denture adhesives. They asked:

- why they had tried denture adhesives, and
- their reasons for using or not using a denture adhesive.

92% of patients had never tried a denture adhesive. Most patients (73%) who did not use denture adhesives managed their dentures well, but a significant number (87%) did not know that denture adhesives existed. Those who had stopped using a denture adhesive complained mainly that it did not improve the fit and chewing ability significantly. The outcome of this survey showed that patients did not have enough knowledge of denture adhesives and that in Istanbul, where the survey took place, it is still generally believed by practitioners that prescribing a denture adhesive is a sign of failure by the dentist.

These results contrast well with many other satisfaction studies like the one by Kulak et al.⁷⁵ Here subjects responded that the retention of their dentures was 'slightly better' to 'much better' when using a denture adhesive.

A more recent and broader study in India showed that 74.5% of denture wearers had never tried a denture adhesive, though 66.9% of dentists claimed to 'use' denture adhesives. A lack of awareness is the main reason for the low number of denture wearers that have tried a denture adhesive. Also, most dentists are still not familiar with their benefits.⁷⁶ By comparing older studies with later ones, we may see a positive change in attitude by denture wearers towards the use of denture adhesives. However, the current situation seems to depend a lot on the specifics of the country, the level of education, cultural differences and the socio-economic levels of the groups researched.

A 2015 survey on dentists' attitude to denture adhesives shows that in the metropolitan area of Athens, Greece, a significant proportion of dentists (60.3%) recommend the use of denture adhesives and do so more often as a continuous regime for both existing and new denture wearers. Sex, age, training and awareness level proved to be factors affecting only a few dentists' attitudes.²¹

There is a lack of knowledge of the potential health benefits of denture adhesives, and a low level of professional recommendation of – or even a denial of – their use with well-fitting dentures. These may be the reasons why most full-denture wearers do not make appropriate and regular use of denture adhesives to help them live their lives to the full. In some countries we do see the dental curriculum including the types and use of denture adhesives more than before. But the benefits that they can deliver are not always part of this. Younger dental professionals seem to be more likely to accept the use of denture adhesives for the wellbeing of their patients, while older professionals are more conservative and are not promoting denture adhesives actively.

Most manufacturers use drawings on the packaging of the denture adhesives for recommending the exact amount used and appropriate application method. The size of the nozzles can be different. Therefore the application pattern for each product needs to be tailored to its nozzle. Some manufacturers have brought to the market adhesive products with a small nozzle on the tube, for easier application and specifically to limit overdosage. For this specific product, small stripes are recommended rather than dots.

We therefore recommend that the Oral Health Foundation and main manufacturers refer to different nozzle types and use application pictures that clearly demonstrate what a 'small amount' is for the particular product.

However, it is not enough just to suggest dental professionals recommend the use of denture adhesives more often and in a more consistent way. We first have to make sure that patients know what the guidelines are for their correct use. Only the correct use of denture adhesives will deliver the possible health benefits for denture wearers, and avoid misuse and overuse that may create oral and general health problems. Dental professionals, being the first line of communication with their denture-wearing patients, have to play this role effectively.

We need standardised guidelines for the proper use, application and removal of denture adhesives.

Unfortunately, it is clear that the available evidence we have to support most guidelines for using denture adhesives covers periods no longer than 6 months.

Based on the existing scientific evidence, information on the safe use of denture adhesives, and tested protocols for their application and removal, we can suggest optimal guidelines as follows:

- 1. Apply a small amount of denture adhesive cream to a clean and dry denture. One application a day should be sufficient.**
- 2. After application, replace the denture in the mouth and firmly close the mouth for a couple of seconds. If the adhesive cream overflows, too much has been applied and the adhesive should be removed (rather than swallowed). Patients should not consume food or drink within the first 5 minutes of application.**
- 3. Before sleep, the denture should be removed and the denture and oral cavity thoroughly cleaned to remove any remaining adhesive.**
- 4. All patients who wear removable dentures should be enrolled into a regular recall and maintenance programme with their dental professional.**

○ Section 10:

Evidence for consistent professional recommendations for denture adhesives

The FDI World Dental Federation recently developed a new and broader definition of oral health: 'Oral health is multi-faceted and includes the ability to speak, smile, smell, taste, touch, chew, swallow and convey a range of emotions through facial expressions with confidence and without pain, discomfort and disease of the craniofacial complex'.

The FDI also states that oral health reflects the physiological, social and psychological attributes that are essential to quality of life, and that it is influenced by the individual's changing experiences, perceptions, expectations and ability to adapt to circumstances.

Because dental practitioners are professionals who deliver 'oral health', this new definition of oral health should also guide them when delivering prosthodontic treatments, such as removable full dentures.

Nowadays patient satisfaction has become the decisive factor in deciding on the overall success of prosthodontic treatment in complete-denture wearers. Because denture adhesives deliver greater patient satisfaction and wellbeing, their recommendation by professionals may contribute to the complete success of a denture-making procedure.

A consumer study by GlaxoSmithKline Consumer Healthcare (data on file) listed the main benefits of using a denture adhesive (as seen by denture wearers):

- ability to eat whenever, wherever, and all types of food – including favourite foods
- absence of pain – adhesives keep food particles from lodging under the denture
- adds a layer of comfort
- confidence while in public and therefore freedom to laugh, smile, cough, sneeze and move around
- peace of mind, freedom from worry, and
- ease of use.

If a reduction in denture movement produces an improvement in chewing function, we would expect to see changes in the kinematic properties of mandibular opening and closing during the chewing cycle. We should also see an increase in the satisfaction level of the individual patient.

So far, the gradual changes in mandible movement patterns in denture wearers have not been studied extensively. A crossover randomised clinical trial could disclose how the masticatory system reacts when a denture adhesive is applied. In turn, this could persuade practitioners to choose a denture adhesive as a useful aid to patient rehabilitation, based on scientific evidence.

Marin et al.³⁷ published such a study. It assessed the effect of a denture adhesive on denture satisfaction and on the kinesiographic measurements of edentulous patients wearing well-fitting full dentures. The kinesiographic recordings revealed a significant increase (1.7 mm) in vertical mandible movements during chewing and a lower (0.3 mm) vertical intrusion of the maxillary complete dentures during chewing after using the denture adhesive. Use of denture adhesive in complete-denture wearers also improved the patients' satisfaction and altered mandible movements. There were increases in vertical movements during chewing and less intrusion of maxillary complete dentures. The findings seem to be valid for edentulous patients of both genders and all ages who were fitted with complete dentures and who exhibited normal volume and resilience values for the residual edentulous ridges. The authors therefore concluded that the use of a denture adhesive was enough to improve patient satisfaction with their complete dentures and to change mandibular movements, leading to improved chewing function.

Other benefits of using a denture adhesive include improved retention and stability, and less accumulation of particles under the denture.

In 2018 Torres-Sanchez et al.²² published a randomised, double-blind crossover study. This assessed the satisfaction of complete-denture users regarding retention, stability and accumulation of particles, with and without adhesive. Satisfaction was measured at baseline and then immediately after each test (two adhesives, with and without adhesive) at 7 and 14 days, using a VAS scale (0-10). The study concluded that denture adhesives significantly improved the satisfaction of full-denture users. This is because there is better retention, better stability and less accumulation of food particles compared with non-use of denture adhesives.

There is no clear guidance on when dentists should eventually recommend and explain the correct use of denture adhesives. From a clinician point of view though, and based on clinical expertise, we advise that at the fit stage dentists must assess the retention and support of the dentures without any adhesive. Otherwise they cannot assess if the dentures are well made. The advice to use adhesives should follow this but will vary between patients. Preferably the dental professional should review the patient only after the initial adaptation phase.

For patients who struggle with compliance, a denture adhesive might improve confidence and quality of life soon after or at the fit stage. For patients who want to reduce food accumulation, recommendation and education about the use of denture adhesives may also be soon after fitting.

The retention and stability of new dentures deteriorate gradually over time. Therefore at review appointments dental professionals should consider whether it is appropriate to give advice for using a denture adhesive. It is well known that, when patients receive new dentures in the dental practice, they are most open to learning. So this is perhaps the best moment to approach with guidelines on denture care and maintenance. The timing for the recommendation on denture adhesives and their appropriate use may be at another follow-up visit, but we are not aware of any evidence on best timing.

We have studied the above clinical findings directly linking denture adhesive use in full-denture wearers to patient satisfaction and therefore wellbeing. Having also taken into account other scientific evidence for improved retention, stability and chewing, we can confidently recommend the following guidance for professional practitioners:

- 1. Patient satisfaction has become a decisive factor for the overall success of prosthodontic treatment in full-denture wearers.**
- 2. Denture adhesives can enhance the retention of, and reduce food accumulation beneath, well-fitting complete dentures.**
- 3. Denture adhesives can be beneficial to the patient. They may enhance comfort, provide psychological satisfaction, increase confidence and thus wellbeing, while increasing retention and stability, and improving function.**
- 4. The effectiveness of denture adhesives cannot compensate for significant denture deficiencies.**
- 5. Dental professionals should provide guidance and instructions to the patient on the correct application and use of the adhesive, and on removing it and cleaning the denture.**
- 6. The optimum time to advise on the use of an adhesive varies between patients. For well-fitting dentures it might occur at a review appointment, or for patients finding problems with compliance at the time of fitting or soon after.**

○ Section 11: **Call for action and next steps**

Worldwide, it seems there are more and more people wearing dentures, which means there are potentially more complete-denture wearers who could be using adhesives. Despite this we were not able to find any clear guidance on the use of adhesives – how to use them, how much to use, and specifics on when and how to remove adhesive from the denture and oral cavity. We found no consistent recommendation on removing the adhesive before going to sleep, nor a recommendation for enrolling complete-denture wearing patients into a regular recall programme.

We therefore recommend that the Oral Health Foundation, the unique international and independent organisation dedicated to improving oral health and wellbeing around the world, uses this white paper consensus to provide independent and impartial advice on the optimal use of denture adhesives:

- to dental professionals (the first line for recommendations to patients)
- to caregivers for elderly people, and
- directly to denture wearers.

We also acknowledge that there are still serious gaps in the research to provide clinical scientific evidence for optimal use of adhesives, other than for the cream forms. Also, there should be long-term studies on the biologic effects and the overall safety profile of denture adhesives with long-term use (more than 6 months). It has been shown (though in an *in vitro* study⁹) that the tensile bond strength of an adhesive seems to depend on the denture bases it will adhere to. So we need more research in this field to allow the optimal choice of adhesive to be recommended with a particular denture base.

We also recommend that the dental community invests in further research to refine the evidence for more specific guidelines on the use of adhesive products, and in particular how often to apply them and how to remove them.

Research is also needed to find out the optimum volume of adhesive to prevent side effects because of misuse and/or overuse. As to when advice to patients should be given by dental professionals, we can only refer to the insights the expert community has shared with us. Therefore more research into this particular issue may also help dental professionals become more receptive and open to the recommendations for the use of adhesives by their denture-wearing patients.

In terms of biocompatibility, there are not enough long-term (more than 6 months) *in vivo* studies to investigate potential harmful effects of denture adhesives. This is therefore an urgent topic for research.

There is a need for more evidence-based research on how the use of denture adhesives could help patients suffering from xerostomia.

We also need further insight into oral care professionals' attitudes towards recommending denture adhesives for improving the lives of their denture-wearing patients.

Although dental professionals recognise their role in delivering oral health to their patients, there is not yet a full understanding of their role in satisfying patients who have full dentures and in improving their wellbeing.

Since denture adhesives are proven to significantly improve chewing function, it is essential that dental professionals should encourage the use of a denture adhesive. It may improve the diet of the full-denture wearer and their daily intake of necessary nutrition. Equally, denture adhesives can improve the patient's social interactions. They provide better retention and stability of the denture while users are speaking, eating and drinking. The adhesive also may cushion the hard acrylic denture and help overcome sore spots, and avoid the pain of food trapping underneath the denture. These features of a denture adhesive contribute to the overall satisfaction of the patient with their dentures in daily life. The antimicrobial effectiveness of most adhesives is an extra plus for reducing potential microbial contamination of the denture and oral mucosa supporting the denture.

We also recommend that in undergraduate training and postgraduate continuing education, the use of denture adhesives gets the place it deserves.

We need to disseminate more widely the benefits of, and the scientific evidence supporting the value of, using denture adhesives. This is essential to:

- helping complete-denture wearers recognise the improved satisfaction they can get from the use of a denture adhesive, and
- improving the service that a professional can provide by recommending a denture adhesive more often.

We hope that with this document we can finally change the current approach towards denture adhesives in dental practice and lead to an optimised experience for the complete denture patient, giving them better denture-related quality of life.

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