Managing diabetes and periodontal disease

Rajesh Chauhan, David Haslam

There is a higher incidence of periodontal disease in individuals with diabetes, and a growing body of evidence suggests that improving dental health may actually lead to improvements in glycaemic control, which may underline an oral-systemic link. Diabetes UK (2010) estimates that there are 500 000 people with undiagnosed diabetes in the UK. In this article, the authors review the evidence for a link between diabetes and periodontal disease, and look at how healthcare professionals in dental care and primary care can work more closely together in screening individuals with periodontal disease for diabetes, and for individuals with diabetes to be offered dental care in the same way that they are routinely offered retinal screening and foot care.

Article points

1. Periodontal disease is a diabetes-related complication; however, the importance of this link is not widely established.
2. Dental practitioners should form part of an integrated healthcare team, alongside primary care, to identify individuals at risk of diabetes.
3. Improving dental health may lead to improvements in glycaemic control and diagnosis of people living with diabetes.

Key words

- Dental practitioner
- Obesity
- Periodontal disease
- Type 2 diabetes

Overweight or obesity is associated with a number of risk factors, including type 2 diabetes, ischaemic heart disease, hypertensive disease and cancer (Parkin et al, 2011; World Health Organization, 2011). While the complications of diabetes are widely recognised, there is a lack of awareness of a further direct complication – periodontal disease – among many healthcare professionals.

This article examines the association between periodontal disease, type 2 diabetes, and obesity – over and above the previously accepted oral-systemic link. The association between dental hygiene and systemic inflammation (Frisbee et al, 2010) has been linked with a number of inflammatory conditions including Alzheimer's disease (Uppoor et al, 2012). It explores the evidence for a potential bi-directional relationship between periodontitis and diabetes, thus highlighting the need for a more prominent role for the dental practitioner in screening for diabetes and caring for people with diabetes.

Diabetes and periodontal disease – a bi-directional relationship

Over the past 50 years, evidence has emerged of a further complication of diabetes – periodontal disease – that affects the tissues surrounding and supporting the teeth (Löe, 1993; Mealey, 2006; Mealey and Ocampo, 2007). Evidence suggests that diabetes is a major risk factor for periodontal disease, with individuals exhibiting an increased prevalence, level and severity of periodontal destruction compared with healthy adults (Lakschevitz et al, 2011). Indeed, people with diabetes are twice as likely to develop periodontal disease compared with those in the general population (Nelson et al, 1990; Firatli, 1997). However, accurate interpretation of the data has not always been straightforward, due to variations in classification and differences in study design (Mealey, 2006). It has also been reported that individuals with diabetes and retinopathy are up to five times more likely to have advanced

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periodontal disease compared with those without retinal complications (Löe, 1993). Furthermore, periodontal disease is a strong predictor of mortality risk from cardiovascular and renal complications. In Pima Indian populations with type 2 diabetes and severe periodontal disease, deaths from ischaemic heart disease were 2.3-fold higher and 8.5-fold higher from diabetic nephropathy, compared with those with no or mild or moderate (combined) periodontal disease (Saremi et al, 2005). This further underlines the importance of earlier identification of diabetes and suggests a fundamental role for the dental practitioner in the diabetes multidisciplinary team.

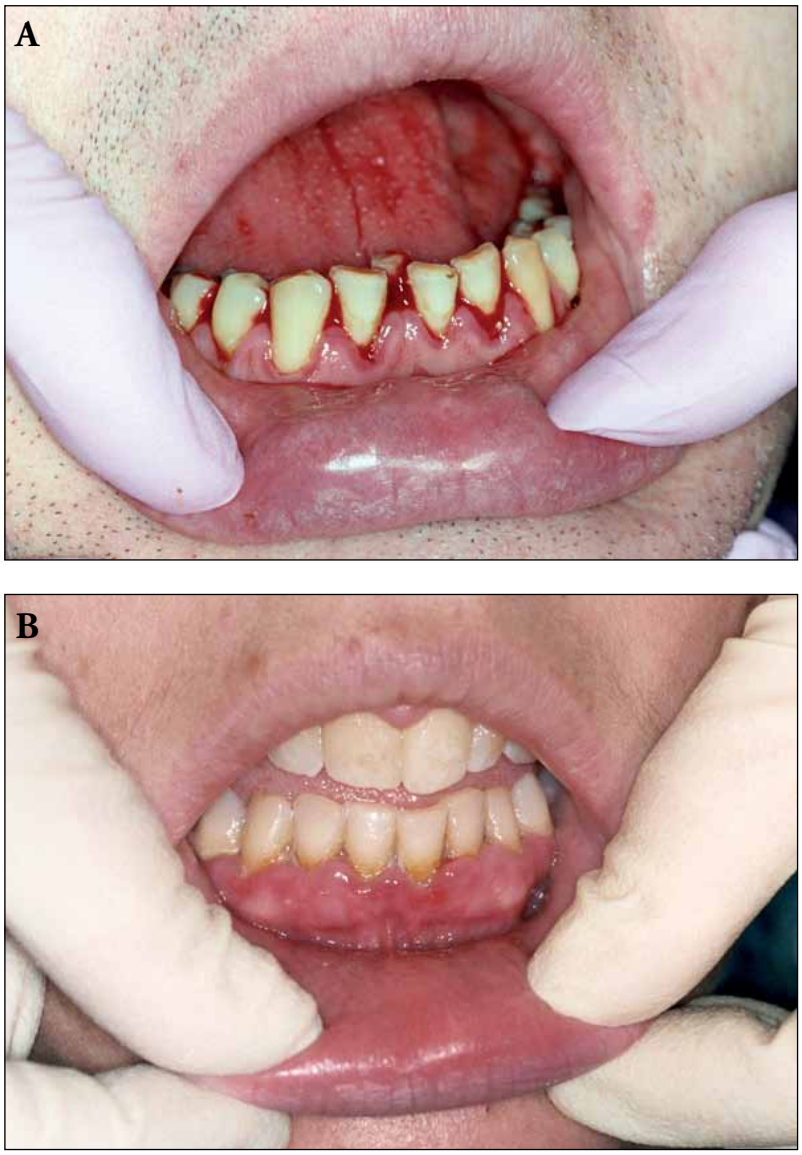


Figure 1. Photographs to show gingivitis and periodontitis in individuals with type 2 diabetes (courtesy of Dr Rajesh Chauhan). A=Photograph of an individual with gingivitis and underlying periodontal disease. If gingivitis were treated at this stage, bone loss due to periodontal disease would be minimal. B=Photograph of an individual with periodontal disease. Accompanying radiographs (not shown) would indicate attachment loss and bone loss.

Periodontal disease

Classification

Periodontal disease is predominantly caused by plaque-induced inflammatory lesions and includes both gingivitis and periodontitis (*Figure 1*).

Gingivitis (inflammation of the gum) occurs where inflamed tissues are associated with a tooth that is not currently losing attachment or bone and has no attachment loss or previous attachment or bone loss (reduced periodontal support). This is commonly associated with the build-up of plaque, which if left untreated, may lead to periodontitis.

Periodontitis, a more advanced and destructive form of periodontal disease, is an inflammatory condition of the dental supporting tissues, caused when specific microorganisms colonise, resulting in progressive destruction of the periodontal ligament and alveolar bone, with pathological pocket formation or recession around diseased teeth, or both (Löe, 1993). This multifactorial process includes microbial challenge alongside other genetic, environmental and acquired risk factors. The destructive tissue changes observed clinically are as a result of the host's inflammatory response.

Prevalence and healthcare burden

A dental health survey carried out in 1998 estimated that over 50% of UK adults aged ≥16 years in the general population had moderate periodontitis (Morris et al, 2001); the figure increased to approximately 67% of people aged 65 years or more, compared with 47% of 25- to 34-year-olds (Morris et al, 2001). The estimated cost of periodontitis to the NHS is over £2.7 billion every year (ATP Consulting, 2008).

The link between periodontal disease, diabetes and obesity

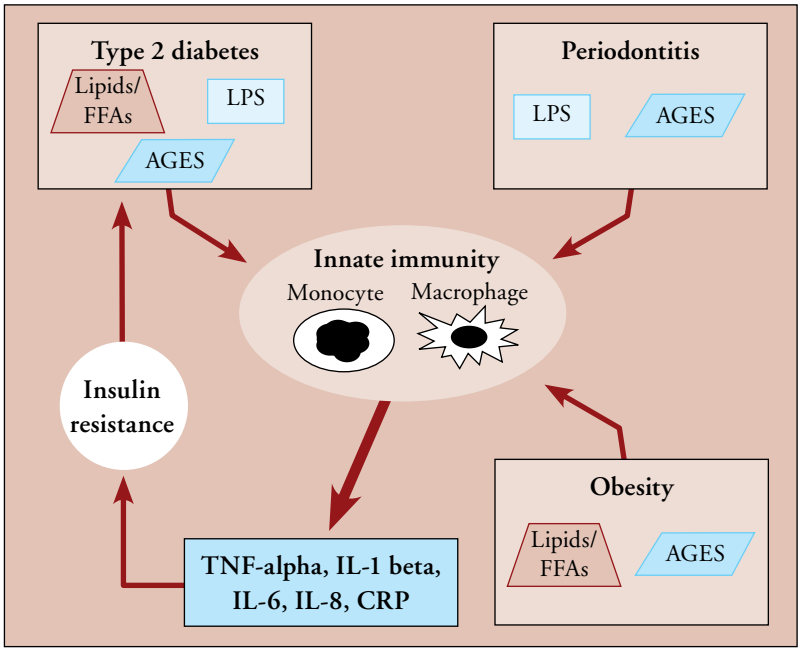
Underlying pathophysiology

Type 2 diabetes is commonly linked to obesity, which contributes to insulin resistance through elevation of circulating free fatty acids, which inhibit glucose update, glycogen synthesis and glycolysis (Santos Tunes et al, 2010). Adipose tissue produces a range of adipocytokines; the levels of which are altered in people with diabetes (Bays et al, 2004). These alterations appear to stimulate pathogenic processes associated with metabolic and cardiovascular disease (Bays et al, 2004). Metabolic control is important in people with diabetes, not only to reduce the risk of developing complications, but also because people with diabetes are more susceptible to infectious disease than those without diabetes – by a 2- to 5-fold risk increase for periodontitis (UKPDS [UK Prospective Diabetes Study] Group, 1998). Thus, a complex bi-directional relationship exists between type 2 diabetes and periodontal disease with each being a risk factor for the other.

Type 2 diabetes, obesity and periodontitis are linked by inflammation, which is triggered by the cytokines produced systemically by adipose tissue and locally by a gum infection (Lundin et al, 2004). Activation of the body's innate immune system produces a cytokine-induced response, resulting in low-grade inflammation and increased concentrations of various acute-phase markers and pro-inflammatory cytokines (Santos Tunes et al, 2010; *Figure 2*). Among these, increased levels of tumour necrosis factor (TNF)-alpha, interleukin (IL)-1 beta, IL-6 and IL-8 have been found in gingival crevicular fluid (an inflammatory exudate that collects in the gingival crevice), suggesting an important role in the inflammatory process (Santos Tunes et al, 2010). TNF-alpha is vital in the pathogenesis and development of periodontitis and increased concentrations can cause insulin resistance (Mealey and Ocampo, 2007). One pioneering study reported that people with diabetes and hyperglycaemia had almost twice the amount of IL-1 beta compared with individuals with controlled glycaemia (Cohen et al, 1970), and cytokine concentration was related to glycaemic control. IL-6 stimulates TNF-alpha production and increased levels in obese individuals results in higher concentrations of both circulating IL-6 and TNF-alpha (Lundin et al, 2004). IL-8 is secreted in response to numerous stimuli including TNF-alpha, and is enhanced in individuals with periodontitis (Lundin et al, 2004). Increased concentrations of cytokines also lead to amplified C-reactive protein production, which may impact further on insulin resistance (Mealey and Ocampo, 2007).

Inappropriate cytokine production or secretion, either in type or in quantity, indicates a dysregulated immune response that can lead to periodontal tissue destruction in the presence of gram-negative bacteria. Both periodontitis and chronic periodontal infections can initiate or perpetuate insulin resistance and glycaemia in a similar way to obesity; locally produced cytokines move into the systemic circulation enhancing the immune response and exacerbating an elevated inflammatory state (Mealey and Rose, 2008; Santos Tunes et al,

Figure 2. Common mediators and pro-inflammatory markers of innate immunity in type 2 diabetes, periodontitis and obesity (adapted from Santos Tunes et al, 2010). Inappropriate secretion of such molecules may perpetuate an inflammatory state, worsening diabetes and leading to the destruction of periodontal tissue. AGES=advanced glycation end products; CRP=C-reactive protein; FFAs=free fatty acids; IL=interleukin; LPS=lipopolysaccharide; TNF=tumour necrosis factor.



Page points

1. Poor glycaemic control is associated with an increase in the risk of developing diabetes complications. The link between periodontitis and diabetes is also more pronounced with reduced glycaemic control and the extent of control is likely to be a key factor in determining risk.
2. Older studies have suggested that a combination of scaling and root planing with systemic doxycycline therapy is associated with improvement in periodontal health, accompanied by significant improvement in glycaemic control, as measured by HbA_{1c}.
3. Further research in this area is required. A randomised control trial should be carried out, with a cohort of people with a similar baseline grade of periodontal disease and HbA_{1c} divided into two groups: one group receiving usual diabetes care and the other group receiving usual care plus management of periodontal disease.

2010), which can worsen diabetes.

The formation of advanced glycaemic end-products – reported to be central to a number of diabetes complications – also occurs in the periodontium (Mealey and Ocampo, 2007).

Evidence for improving glycaemic control

Poor glycaemic control is associated with an increase in the risk of developing diabetes complications (UKPDS, 1998). The link between periodontitis and diabetes is also more pronounced with reduced glycaemic control (Tsai et al, 2002) and the extent of control is likely to be a key factor in determining risk. In a large American epidemiological study, adults with poorly controlled diabetes had a 2.9-fold increased risk for periodontitis compared with those without diabetes. Interestingly, individuals whose diabetes was well controlled had no significant increase in risk (Tsai et al, 2002).

Reducing inflammation after periodontal therapy may help to restore insulin sensitivity and is associated with improved glycaemic control. Indeed, successful periodontal treatment that also removes any microbial biofilm, may further reduce levels of circulating TNF-alpha in people with periodontal disease, thereby improving diabetes control through the reduction of insulin resistance (Mealey and Rose, 2008).

Older studies have also suggested that a combination of scaling and root planing with systemic doxycycline therapy is associated with improvement in periodontal health, accompanied by significant improvement in glycaemic control, as measured by HbA_{1c} (Grossi et al, 1996; Grossi et al, 1997). However, these studies are notoriously difficult to interpret, as other simultaneous glucose-lowering interventions may have confounded the results, or individuals may have simply decided to improve their glycaemic control, and periodontal health at the same time. Some participants demonstrated marked improvement in glycaemic control after periodontal intervention, while others demonstrated no change in HbA_{1c} after similar regimens (Stewart et al, 2001). Consequently, the jury is out on the exact extent of the bi-directional link.

Further research in this area is required. A randomised control trial should be carried out, with a cohort of people with a similar baseline grade of periodontal disease and HbA_{1c} divided into two groups: one group receiving usual diabetes care and the other group receiving usual care plus management of periodontal disease. This would demonstrate whether or not treatment of periodontal disease has a specific impact in improving HbA_{1c} and other cardiometabolic parameters, and therefore whether the periodontal disease process has a role in deteriorating glycaemic control, and whether it is a valid target in the management of diabetes. The authors call for this research to be undertaken.

Role of the dental practitioner and the GP

A recent randomised, controlled, multinational trial confirmed that stepwise screening for diabetes in primary care in high-risk people is effective in identifying those with diabetes and high levels of cardiovascular risk factors that are potentially modifiable (Sandbaek et al, 2008). The diabscreen study (Klein Woolthuis et al, 2009) revealed that targeted screening of high risk individuals in primary care had a good rate of unveiling previously undiagnosed diabetes, but that obesity alone was the best predictor.

Using periodontal disease, with or without the presence of obesity, is likely to be a clinically effective and cost-effective method of screening. Because the mouth may exhibit signs or symptoms of a poorly controlled or undiagnosed diabetes-related condition, and it is clear that a link between oral and systemic health exists, the importance of the dental practitioner in this setting should not be overlooked. It is therefore logical and necessary that dental practitioners should become an integral part of the multidisciplinary team, permitting enquiry about an individual's family history of diabetes or presence of the signs and symptoms. However, to date they have been reluctant to advise on such conditions, from a lack of either confidence or integration into a wider healthcare group. Similarly, GPs may be unaware of the inter-relationship between oral

health and diabetes and, thus, the necessity for cross-referral to ensure optimal diagnosis and management. Communication between both sets of healthcare professionals is often poor.

The link between diabetes and periodontal disease has been acknowledged by the American Diabetes Association (2011), which highlighted the importance of dental practitioner involvement as part of a diabetes evaluation. Despite this, such recommendations have not yet been incorporated into European or UK practice. While NICE (National Collaborating Centre for Chronic Conditions, 2008) recommends various targets for optimal diabetes management (*Box 1*), dental health is not currently addressed.

Approximately half of all people with type 2 diabetes show signs of complications at diagnosis (UKPDS, 1990). However, some individuals may remain undiagnosed for years because hyperglycaemia develops gradually, often without symptoms (Holt et al, 2008). In addition to diagnoses by a GP or diabetologist, opticians and optometrists are often responsible for identifying individuals with diabetes. Microvascular complications of the retina indicate diabetes duration of up to a decade. The UKPDS showed that intensive glucose control, started at diagnosis, is associated with a significantly decreased risk of cardiovascular complications and a reduced risk of microvascular disease over time – the "legacy effect" (Holman et al, 2008). Dental practitioners should be encouraged to promote screening for diabetes, thereby enabling earlier and more effective management of the condition, and also allowing improvement of periodontal disease. This can be done by referral to general practice for broad-based screening, or by near point measuring of HbA_{1c} by dental professionals.

The role of the dental practitioner in obesity prevention and management

The dental professional is ideally placed to offer obesity prevention and management advice and education. It is likely that caries and obesity are linked (Gerdin et al, 2008) and certainly co-exist in children, particularly those of low socioeconomic status (Marshall et al, 2007). Sugar, refined carbohydrates and, in particular, sugar-sweetened beverages impact upon dental health and can lead to obesity (de Silva-Sanigorski et al, 2011; Malik and Hu, 2012).

Consumption of sugary carbonated drinks, powdered beverages, and, to a lesser extent, 100% juice is associated with increased caries risk (Marshall et al, 2003). There is an ideal opportunity to kill two birds with one stone, and provide counselling on both obesity and dental caries, either during a consultation, or by a poster or leaflet campaign. Furthermore, a new cohort of people can be accessed for healthy eating advice, as many teenagers who consult their dental professional for dental and orthodontic work rarely consult their GP. Most dental practitioners are aware that childhood obesity is a major health concern, and express a willingness to assist other healthcare professionals in addressing this problem, but only a small minority actually provide nutrition counselling (Braithwaite et al, 2008). There have been calls among the dental community (for example, Glick, 2005) to institute and monitor behavioural obesity interventions for oral and general health reasons. In addition, simple practical interventions have been described as part of comprehensive dentistry (Hague and Touger–Decker, 2008). One healthy weight intervention carried out by hygienists is described as feasible and well accepted with most participating parents reporting that they made changes to their child's food choices as a result (Tavares and Chomitz, 2009). In Europe and

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Box 1. Multiple targets for reduction of risk and improvement of health in comprehensive diabetes management as recommended by NICE (National Collaborating Centre for Chronic Conditions, 2008).

- Body weight and level of activity
- Management of depression
- Plasma glucose control
- Blood pressure control
- Blood lipid control
- Reduction of thrombogenicity
- Laser therapy for eye damage
- Drug therapy to delay kidney damage
- Local foot care
- Symptomatic treatment for different types of nerve damage

Figure 3. Predicted percentage of the UK population who will be obese in 2015, 2025 and 2050, respectively, based on current trends (Foresight, 2007).

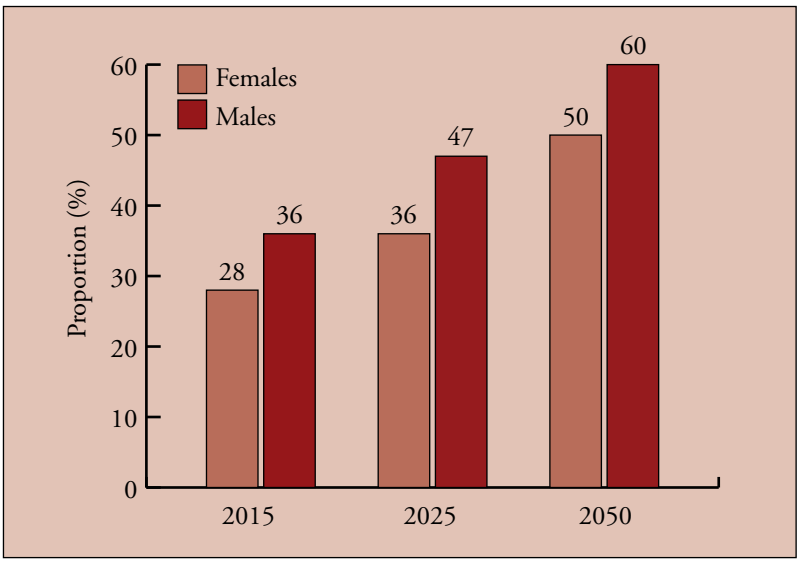
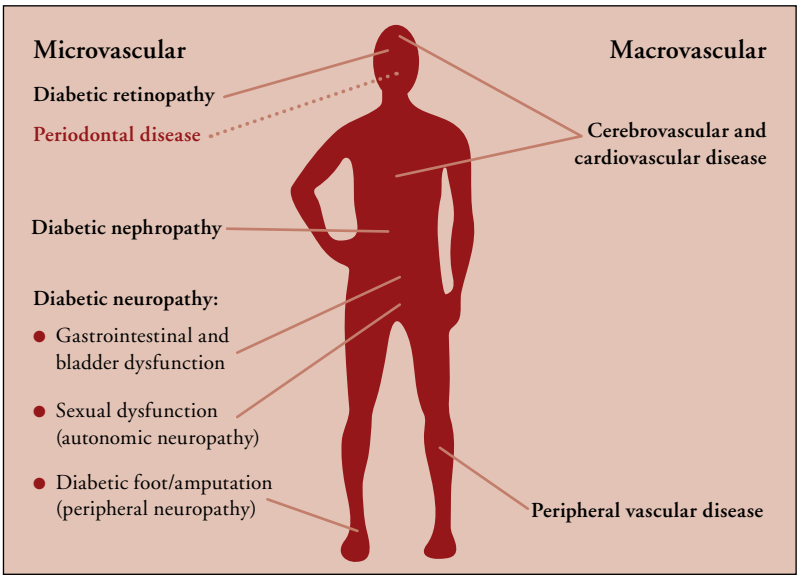


Figure 4. Major long-term or "classical" microvascular and macrovascular complications of diabetes (adapted from: International Diabetes Federation [2006] to include periodontal disease).



America, leading paediatric dentists are calling for dental professionals to "take a bold step forward and embrace a reliance on calculating and monitoring BMI in each child's dental record" (Vann et al, 2005; Cinar et al, 2011)

Conclusion

Obesity and type 2 diabetes, both now at "epidemic" proportions (*Figure 3*), are two of the most concerning healthcare challenges faced today (Yorkshire and Humber Public Health Observatory, 2008; Craig and Hirani, 2010). To reduce the number of people affected by obesity, diabetes and its complications (including periodontal disease), healthcare professionals will need to proactively increase awareness of the risks, to improve self-management and provide a more effective and integrated healthcare solution.

Just as opticians identify retinal complications, dental practitioners should be recognised as a key component of the healthcare team – involved at both diagnosis and routine screening. As the oral cavity may exhibit the initial stages of an undiagnosed or poorly controlled diabetes condition, a greater role for dental practitioners is warranted to identify the first signs of oral disease (*Figure 4*).

Only by dental practitioners working alongside GPs, following recognition of periodontal involvement, will we help to identify individuals with undiagnosed diabetes. Correspondingly, newly diagnosed individuals should be referred routinely to a dental practitioner for further evaluation, thereby opening a two-way channel of communication.

Dental and general healthcare professionals should work together to promote greater awareness and education of the inter-relationship between obesity, type 2 diabetes, periodontal disease and glycaemic control and of the existence of the link between oral and systemic health. A formal call-to-action, through recommendation and incorporation into current UK guidelines for the care of individuals with diabetes, is both overdue and necessary. ■

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Conflict of interest

The authors declare no conflicts of interest in the preparation of this manuscript.

Authors' details

Rajesh Chauhan is a Specialist in Oral Surgery in Primary Care and General Dental Practitioner

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at Watton Place Clinic, Watton-at-Stone, Hertfordshire, a Specialist in Oral Surgery at Lister Hospital, Stevenage and Queen Elizabeth II Hospital, Welwyn Garden City, Hertfordshire and Dental Spokesman for the National Obesity Forum, London. David Haslam is Bariatric Physician, Luton and Dunstable Hospital, Luton, Bedfordshire and Chair of the National Obesity Forum, London.

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