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Bizarre Tooth Surface Loss and the Miswak Stick

Abstract: Tooth surface loss can present in a variety of ways, some of which can appear rather strange on first examination. This case report demonstrates an unusual presentation of tooth surface loss (TSL) and its subsequent treatment. This loss of hard dental tissue appeared to be affecting the whole of the patient's remaining dentition, both lingually and buccally. Detailed questioning revealed the origins of this problem which turned out to be due to excessive use of an intra-oral Miswak chewing stick.

Clinical Relevance: This article will enable clinicians to understand the importance of specific, targeted history-taking, involving a rare case of tooth surface loss as well as the use of minimally destructive restoration composites and a fibre-reinforced composite bridge.

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Tooth surface loss, affecting both the lingual and buccal aspects of teeth presenting as a generalized pattern, is a relatively rarely reported pathological finding. More commonly, tooth surface loss occurs mainly on the palatal aspects of teeth (eg in cases of bulimia or gastro-oesophageal reflux disease (commonly abbreviated to GORD), or on the incisal or occlusal surfaces of teeth, or a combination of both depending on the various aetiological factors.

There are a number of different descriptions and indices of tooth surface loss, some implying a supposedly definite aetiology. In 1982, Eccles described 'tooth surface loss' as a pathological loss of hard tooth tissue by a disease process other than dental caries.¹

The aetiological factors responsible for tooth surface loss are usually described as belonging in one of the following main categories:

- Erosion;
- Attrition;
- Abrasion;
- 'Abfraction'. This is a very controversial term and considerable doubt exists within the dental profession about the term itself or its supposed pathogenesis.

Tooth surface loss can be a progressive phenomenon, but it can also present as a reflection of past habits and/or of only slowly progressive tooth surface loss.

The primary focus prior to treatment planning should be on establishing the probable aetiology in the first place to increase the likelihood of an effective preventive strategy for that particular aetiological factor, thereby increasing the chances of a long-term successful outcome for that particular patient and diminishing the chances of inappropriate interventions for that individual patient.

Case report

This case report describes an unusual cause of severe generalized

pathological tooth surface loss. This 52-year-old lady presented to the Restorative Clinic at King's College Dental Institute, London, for assessment about replacing a lower central incisor which she had lost due to a traumatic injury. On clinical examination a generalized pattern of cervical tooth surface loss was observed affecting both the buccal and lingual surfaces of her adult dentition, accompanied by generalized gingival recession (Figure 1 a–d).

This case report demonstrates that, although detailed history-taking about dietary and regurgitation issues still remain important in trying to ascertain the possible causes of tooth surface loss, habits, including the use of unusual tools to maintain oral hygiene, or bizarre methods of use of more conventional ones, such as flossing, are also sensible lines of enquiry.²

The cervical portions of the enamel had been lost completely on many teeth and much, or all, of the way through dentine. In some areas, this exposed where the pulp had been.

Medically, the patient was fit and healthy and was not taking any medication. She specifically denied ever having had any gastric regurgitation type problems and was not a vegetarian. As a result, this pattern of tooth surface loss did not appear to be

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attributable to any medical cause. She had no clinically detectable caries and signs of significant active periodontal disease were absent. A basic periodontal examination revealed a score of 2 in every sextant, although there was significant recession obvious both labially and lingually.

Positive results were gained from sensibility ('vitality') testing of her remaining dentition with cold and electric pulp testing. Further detailed questioning about her diet revealed no present or previous abnormal intake of any erosive fluids or unusual dietary habits.

The patient was a clerical worker by occupation and enquiry about unusual habits did not reveal anything untoward. Further detailed and sensitive questioning of the patient about her oral hygiene habits uncovered the probable aetiological factor behind this unusual presentation. It appeared that this patient had been using an African chewing stick, known as 'Miswak', to clean her teeth instead of using a conventional toothbrush.

An internet search and demonstration of its use (Figure 2) brought to light the details of the Miswak stick's abrasive nature.³

Origin of the chewing stick

Chewing sticks are used internationally, but especially in parts of the world such as Africa, India and the Middle East (Figure 3). They have been known to have been used by the Babylonians approximately 7000 years ago. They appear to have been utilized by ancient Greeks, Romans and Egyptians. Many versions of such a stick exist and the wood used to make these 'Miswaks' comes from a variety of trees that are found all over the world (Table 1).⁴

The roots, twigs and stems of these evergreen trees are all used as oral hygiene tools. These trees are largely upright, have aromatic roots and usually do not exceed a height of 3 metres. The sticks are harvested, bundled together and sold in local markets as toothbrushes or tongue-cleaning aids.⁴

The low cost, ready availability, as well as it being favoured for different cultural and religious reasons,⁵ make this a popular oral hygiene tool, particularly in developing countries. The use was

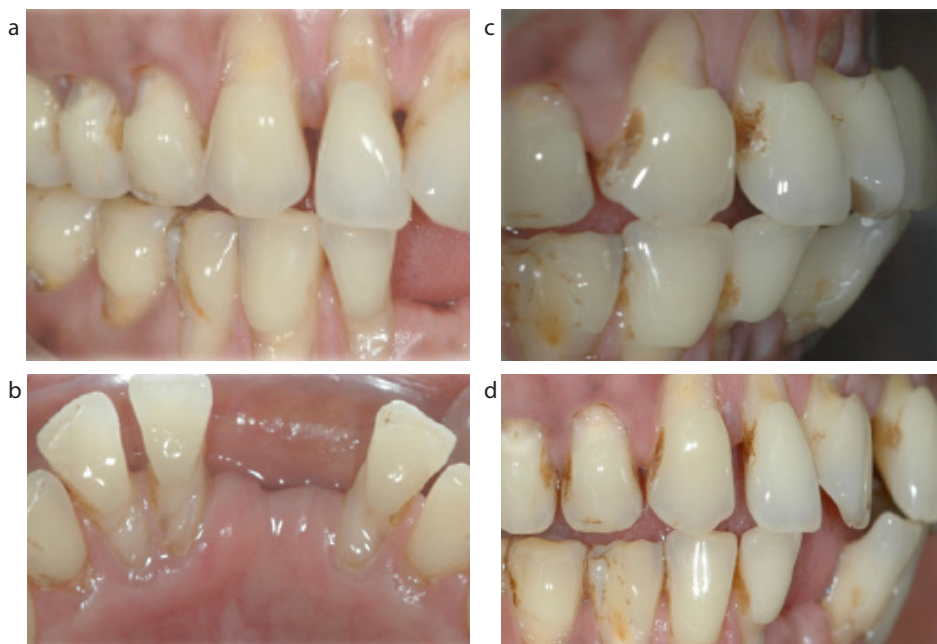


Figure 1. (a) Labial view of right side demonstrating cervical tooth surface loss and gingival recession (b) Lingual view of lower incisor teeth, demonstrating cervical tooth surface loss. (c, d) Lateral view exhibiting the severity of cervical tooth surface loss, all the way through significant parts of the dentine.

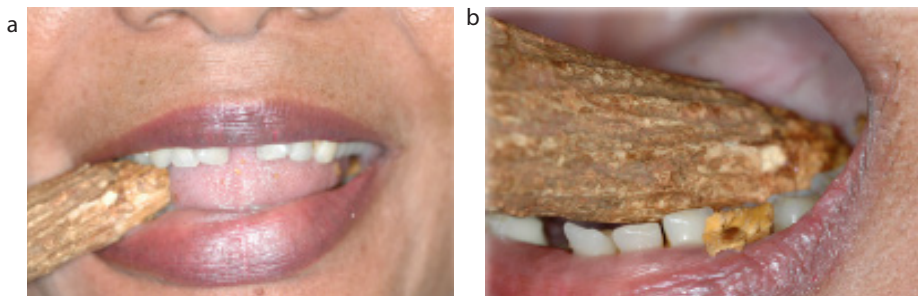


Figure 2. (a) Patient demonstrating chewing of Miswak, prior to its use. (b) Patient demonstrating use of a Miswak stick lingually.

endorsed by the World Health Organization in 1986 and 2000 in international consensus reports.

Method of use of the stick

The stick measures approximately 15–20 cm and can have a diameter of up to 1.5 cm. Typically, the stick is chewed at one end (Figure 2a) until the bark becomes soft and frays. Once frayed, patients use the stick in a scrubbing motion, on every surface of the tooth, including buccal and lingual surfaces as shown (Figure 2b). The fibres of the Miswak are orientated in the same direction as the long axis of the stick and therefore allow easier access to the buccal surfaces of the

teeth, when used in a horizontal motion, and to the lingual surfaces, when used in a vertical direction, as is most commonly practised. This is in contrast to a conventional toothbrush where the bristles are orientated perpendicular to the handle. This means that access interdentally is somewhat more restricted with the Miswak stick and may explain the staining found on the interproximal surfaces of this patient's dentition.

At times, patients may moisten the stick to speed up the effect and thereafter, rather than replace the whole stick, the frayed end is cut before it is re-used. Toothpaste is usually not available and not used with this

toothbrushing stick and apparently was not used by this patient.

Properties of the Miswak stick

The benefits for the use of the Miswak in relation to oral hygiene are primarily owing to its chemomechanical properties.⁴ The frayed end serves to remove the build-up of plaque mechanically, whilst, the 'sap' of the stick contains many agents that have been found to have antimicrobial effects. Evidence for the use of Miswak, however, is controversial.

Mechanical effect on plaque

This is certainly an important factor as it has been shown that the mechanical cleaning of plaque can be a

highly effective preventive measure for the control of gingivitis and caries progression.⁶

In fact, it has been found that the periodontal treatment need amongst a Saudi Arabian population using Miswak sticks is lower than non-users.⁷

Other studies, however, have found that the effect of the Miswak and the use of a toothbrush are similar in the mechanical removal of plaque,⁸ or that the former is less effective. For example, in a study comparing the use of a toothbrush and Miswak chewing sticks, it was concluded that, for patients with severe plaque deposits, the toothbrush is more effective than the chewing stick in plaque control. However, for those patients with moderate plaque deposits, the chewing stick was as efficacious as the toothbrush in

plaque control. One can argue that, in this particular study, the sample size was too low to make valid inferences.⁹

Antimicrobial effects

Apart from the mechanical effects that the Miswak stick may have on the removal of plaque, many naturally occurring chemicals have been isolated from this chewing stick that have been found to have some beneficial effects (Table 2). These include: saponins along with tannins, silica, a small amount of resin, trimethylamine and a fairly large amount of alkaloidal constituents. In addition to this, benzyl-isothiocyanate has been isolated from the roots of the tree.¹⁰

This is supported by gas chromatography mass spectrometry analyses of the root oil, which revealed that it consists mainly of Benzyl-isothiocyanate (70%) which is known to have antibacterial activity.¹¹

Many studies have further investigated the effect of the chemicals found in Miswak on oral health. One study¹⁴ suggests that the Miswak stick has inhibitory effects on common pathogenic bacteria, such as *Aggregatibacter actinomycetemcomitans* and *Porphyromonas gingivalis*, but less so on cariogenic bacteria, such as *Lactobacillus acidophilus* or *Streptococcus mutans*. This is corroborated by a study comparing the effect of seven different types of chewing sticks, where it was found that there was an antimicrobial effect on *Enterococcus faecalis* at 50% concentration of Kikar (*Acacia arabia*) from Pakistan and Arak (*Salvadora persica*) from Saudi Arabia, but had little effect on

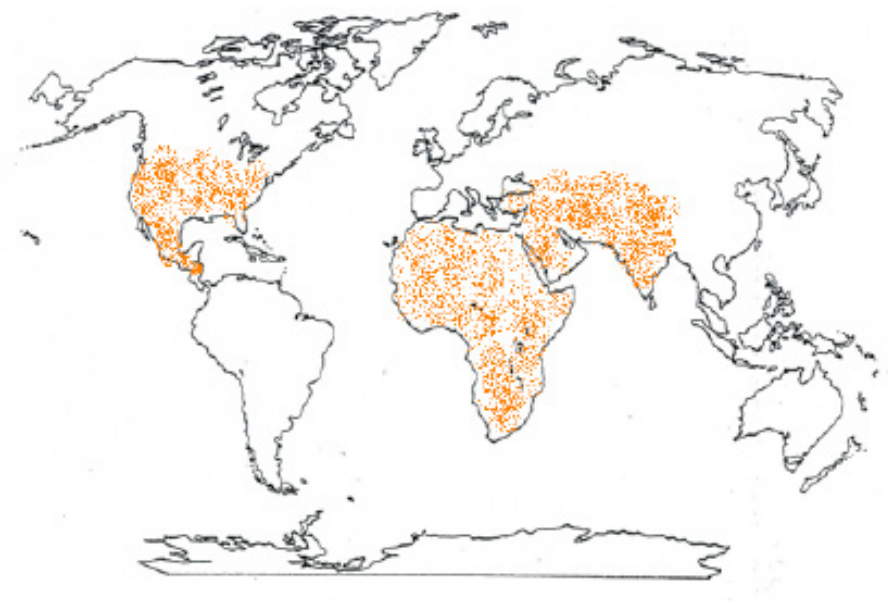


Figure 3. Main distribution of Miswak use around the world.

Botanical Name	Local Name	Main Area of Use
<i>Salvadora persica</i>	Arak	Middle East
<i>Citrus aurantifolia</i>	Lime Tree	West Africa
<i>Citrus sinensis</i>	Orange Tree	West Africa
<i>Cassia sieberiana</i>	Roots of Senna	Sierra Leone
<i>Azadirachta indica</i>	Neem	India
<i>Betula lenta</i>	Cherry Birch/ Black Birch	North America
<i>Gaultheria procumbens</i>	American Wintergreen	North America

Table 1. Various trees that are used to produce the Miswak stick.

Chemical	Property
Saponins	Antioxidant, antifungal and virucidal ¹²
Tannins	Antimicrobial, antioxidant and astringent ¹³
Silica	Abrasive
Alkaloids	Analgesic
Benzyl-isothiocyanate	Antimicrobial ¹¹

Table 2. Main constituents of Miswak and their properties.

Streptococcus mutans, *Staphylococcus aureus* and *Candida albicans*.¹⁵ In contrast, Almas and Al-Zeid¹⁶ investigated the immediate antimicrobial effects of *S. persica* Miswak and its extract on *Streptococcus mutans* and *Lactobacillus*, and found a significant decrease in *Streptococcus mutans* count, but not in *Lactobacillus* count, in Miswak users. Other studies also support the antimicrobial effect on *Enterococcus faecalis* where it was found that it was the most sensitive micro-organism to be affected by the use of *S. persica* Miswak.^{15,17}

Having looked at the mechanical and antimicrobial effect of Miswak, the actual efficacy of its use has been challenged in a number of studies, however, and current evidence suggests that it is either no better than conventional oral health aids or the results are inconclusive.⁴ For example, it has been found that Miswak users harboured significantly higher plaque levels of *Staphylococcus intermedius*, *A. actinomycetemcomitans*, *Veillonellaparvula*, *Actinomyces israelii* and *Capnocytophaga gingivalis*, as well as significantly lower levels of *Selenomonas sputigena*, *Streptococcus salivarius*, *Streptococcus oralis* and *Actinomyces naeslundii*, than did toothbrush users.¹⁸ This is supported by a pilot study¹⁹ which reports more plaque formation and gingival bleeding in people using chewing sticks than toothbrush users. This is despite finding a decrease in the rate of caries progression in such users.

In addition, a retrospective study conducted in Saudi Arabia showed Miswak users had deeper periodontal pockets and a higher prevalence of periodontal diseases than did non-users.²⁰

Although conflicting results have been found suggesting the efficacious use of the Miswak, there seems to be a

positive relationship between its use and gingival recession,^{21,22} which may explain the clinical appearance observed in the patient in this study.

Discussion

Despite the conflicting evidence base, this patient presented with no evidence of caries and did not suffer from noticeable active periodontal disease, although the significant recession was noted, which might well be expected after reviewing many of the above studies.^{21,22} At first, however, one might be forgiven for guessing that this presentation resembles that associated with the controversial theory of 'abfraction.' However, further enquiry revealed that, in fact, this was not true.

Abfraction lesions have been reported to present primarily at the cervical region of the dentition and are typically wedge-shaped, with sharp internal and external line angles. This appearance is supposed to be caused by excessive occlusal stress and masticatory forces.^{23,24} However, so far there has been little in the way of scientific literature to prove that this phenomenon actually exists, especially as these supposedly excessive occlusal forces should affect both the buccal and lingual aspects of the dentition equally.²⁵ In particular, it has been reported that these lesions are found more prominently in the maxilla rather than the mandible and preferentially on premolars, canines and incisors.²⁵ This is unlikely to be the cause of this particular clinical presentation reported by these authors, where there has been no obvious evidence of parafunction or grinding.

Detailed, culturally sensitive, enquiry into patient habits is considered

to be a very important part of the history-taking process in trying to determine the cause of the tooth surface loss, but one may quickly overlook such rare, but salient facts, in order to attribute the tooth surface loss to a particular 'preferred' cause, such as abfraction, which was the speculative diagnosis offered by the referring general dental practitioner.

A reasonable question about the existence of 'abfraction' as a discrete pathologic entity could be: 'If excessive occlusal forces really did produce this sort of cervical tooth surface loss how come one does not see this cervical tooth surface loss also in every wear case involving mainly attrition, considering that massive forces are involved in the tooth-to-tooth grinding producing that incisal and occlusal wear?'

Patients will not always be obliging in revealing details of their (oral hygiene) habits unless they are specifically asked. Many may not realize the relationship between their cleaning approaches and their clinical dental presentation. Taking adequate time to build rapport and allow sensitive questioning into patient oral hygiene procedures cannot only reveal the frequency in which patients brush but the manner in which they do so and the tools that they choose for this. Once the correct information has been gleaned from the patient, this approach enables the clinician to discuss with the patient the adoption of more appropriate preventive measures which should be of greater benefit to that individual patient.

Links between toothwear and other oral cleaning habits have, indeed, been found and²⁶ may have contributed to the pattern of gingival recession shown in this case.^{21,22}

Treatment

Initial treatment for this patient consisted of toothbrushing instruction with a medium toothbrush and a modified Bass technique. This would ensure that any future treatment would not be jeopardized by continual brushing using the chewing stick. Furthermore, as can be seen from Figure 1, this habit had hastened the process of gingival recession. The patient was advised that, although this process could not be reversed, it could be controlled.

The size and extent of the lesions meant that the remaining tooth structure needed to be protected. Treatment consisted of adding direct resin composite to the affected areas of the remaining dentition in order to prevent further weakening of her teeth and help avoid possible pulpal irritation (Figure 4). This form of treatment is biologically acceptable and preserves as much of the remaining structure as possible.

In addition, this could facilitate the impression-taking stage, when fabricating replacement prosthesis for her lower central incisor, which was this patient's initial presenting complaint.

The options for replacing the lower central incisor that were considered with the patient were:

- A removable partial denture;
- A fixed resin-bonded bridge;
- A fixed conventional bridge;
- A fibre-reinforced bridge; or
- A single tooth implant.

The patient was not keen on a surgical option and therefore declined implant therapy. However, she was keen to explore both removable and other fixed options. A removable partial denture would have permitted the replacement of soft tissue and hard tissue and, though removable, would be likely to offer this patient a good aesthetic advantage. In addition, as the long-term prognosis of the adjacent incisors was guarded, it was felt that, in due course, these could be added to the prosthesis. The idea of a resin-bonded bridge was explained to the patient and, being fixed, appeared advantageous to the patient, however, this approach would not provide soft tissue replacement. Metal shine through might also have been a significant issue in this case. An alternative to these, involving a fibre-reinforced composite bridge, was then considered because there would be less aesthetic compromise as the metal-retaining pad would not show through.²⁷

Fibre-reinforced composite bridges are, by definition, resin-based restorations containing fibres aimed at enhancing their physical properties, largely by reduction in crack propagation.²⁸ Their use in fixed prosthetic dentistry was first described in 1990,²⁹ although its applications in dentistry first originate back to the 1960s.³⁰ Fibre reinforcement,

allegedly permits stresses to be redistributed more effectively throughout the restoration, conferring increased fatigue resistance to composite when compared to simple metal wire reinforcement.³¹

The fibres can be made from glass, ultra high molecular weight polyethylene, or Kevlar fibres and can vary in arrangement from uni-directional to multi-directional. The resin used fixes the fibres in place and provides further reinforcement to the restoration.²⁸ In this case, 'EverStick' fibres were used (Sticktech Ltd, Turku, Finland) where the multi-directional fibres are pre-impregnated with light-curable monomers (PMMA) permitting cross-linking to occur with the overlying composite resin material used, thereby forming an effective network.

The adjacent teeth were isolated with rubber dam, before applying acid etch and a three bottle bonding system (*Allbond 2*, Bisco Inc, USA). The fibres were then fixed in place using flowable composite and a mesial cantilever design was used to provide replacement for this patient's missing lower central incisor (Figure 5).

Only short-term clinical data are currently available to compare these fibre-reinforced resin composites to the metal-based alternatives and the optimal design characteristics still remain to be established.²⁷ In addition, the evidence base for the survival rates of fibre-reinforced composite bridges is considerably less than that available for metal retainer sub-frames. However, the technique provides an economic, direct, minimally destructive and aesthetic alternative to other conventional methods to replace anterior teeth in patients such as this. It can also be utilized when dealing with spaces within developing dentitions or for interim fixed prostheses, such as immediately after implant placement to avoid the use of a removable denture. The treatment can be completed in a single visit, does not require temporization, has low biologic cost and good operator control, in terms of shade, shape and repairs.^{27,32} Having said this, this method is reasonably demanding, especially when considering the shape of pontic and span size³² and can require more occlusal clearance for the retainers, although this was not a particular problem in this case.²⁷

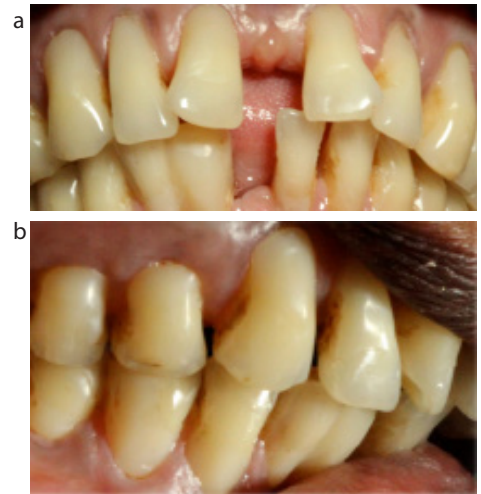


Figure 4. (a) Labial and (b) lateral views demonstrating composite resin addition to remaining tooth structure.



Figure 5. Fibre-reinforced composite bridge replacing LR1.



Figure 6. Post-operative view maintaining original midline diastema.

Conclusions

This report highlights the importance of sensitive and detailed history-taking as an aid to sound diagnosis and treatment planning. In this case, it

revealed an unusual aetiological factor of what is now becoming a slightly more common clinical presentation in the UK and elsewhere owing to increased and changing patterns of immigration and travel. The importance of adequate preventive measures, particularly using a less destructive oral hygiene instruction, was required prior to starting active treatment. A minimally destructive treatment plan was put together in order to preserve what tooth structure remained, and such a pragmatic philosophical approach is well reported in the literature.³³ Application of the above minimally destructive methods resulted in restoration of a functional, aesthetic and biologically acceptable outcome for this particular patient (Figure 6).

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