WHITE SPOTS

Unlock the mystery
Identify the problem
Find the appropriate treatment solution

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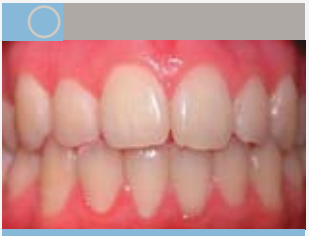
GC

Appearance of normal enamel

Normal enamel should have a lustrous surface which reflects light from the surface and from the subsurface. In the enamel of permanent teeth, the reflection of blue light is slightly less than other wavelengths, which gives the teeth a warm yellow/red underlying hue in most cases.

Regardless of the shape of the crowns of the teeth, the reflection and scattering of light from the surface and subsurface should be even.



Prof. Laurie Walsh

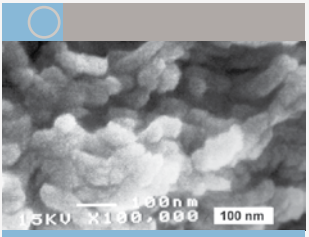
Healthy unrestored enamel reflects incident light, and emits fluorescence in the visible spectrum. Absorption of light gives the teeth their unique shade.

Disturbances in enamel

The structure of fully formed permanent human enamel, when viewed at high magnification, shows the presence of individual crystallites with microscopic spaces between, which are normally occupied by water molecules.

The individual crystals of mineral form during the mineralization process, and at the same time, water and proteins are removed. Disturbances in the formation of the enamel matrix and in the mineralization of the matrix can result in the retention of excess water and proteins which then changes the reflection and scatter of light from the enamel surface.

Ameloblasts are highly specialized cells that are sensitive to a broad range of environmental influences. For this reason, a large number of factors can contribute to hypomineralization. There are multiple conditions that have been documented that affect the formation of enamel.



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High magnification scanning electron micrograph, showing individual crystallites of mineral.

Examination history

A historical record of the patient's residence in various areas is important information, as is the level of fluoride present in the respective water sources. Any supplementary fluoride history should also be determined.

It is particularly important to record the patient's medical history during the years of tooth formation and careful documentation of this is often very informative. Specific questioning should be undertaken in relation to perinatal fevers and other illnesses, given that these are very common contributing factors to enamel defects. A correlation between the timing of the medical problem and the corresponding defect in the enamel can help to distinguish between factors, where several are operating.

Examination diagnosis

When undertaking a clinical diagnosis of enamel defects, the teeth should be dry and observed with cheek retractors in place, and under good lighting conditions. With some particular conditions involving tetracycline drugs or porphyrins, the use of a long wavelength ultraviolet light source can be informative, since this elicits fluorescence in characteristic patterns; red fluorescence from the porphyrins and yellow/green fluorescence from tetracyclines. Note that if UV light sources are used, it is important to remove all plaque, since plaque has a natural extrinsic visible red fluorescence when excited in the long wavelength ultraviolet region.

Differential diagnosis

In terms of identifying factors where multiple teeth are affected, systemic and genetic factors should be considered. Fluorosis is an excellent example of a systemic influence. Where a single tooth is affected, a local factor will be implicated, and trauma or infection of the deciduous teeth affecting the underlying permanent teeth is a classic example of this.

An accurate knowledge of the process and chronology of tooth formation is important for giving an expert assessment of the likely cause and timing of enamel defects. Patients may be concerned that factors which affect the enamel matrix may have also affected their skeletal tissues. Unlike enamel and dentine, bone is a highly labile structure and is turned over, thus it is not common to see impacts upon bone unless there are powerful systemic factors at work, e.g. extremely high intakes of fluoride.

Genetic factors which may affect enamel are relatively uncommon, whereas environmental factors are normally implicated. More than fifty conditions have been associated with developmental defects of enamel, and therefore the clinician should consider amelogenesis imperfecta and other less common conditions where the history, appearance and chronology do not align with local factors. Some forms of amelogenesis imperfecta have pathognomonic appearances with patterns of grooving and reductions in the thickness of enamel. The diagnosis of this condition can be made both from the clinical appearance and from a careful pedigree, which dictates which individuals in a family have been affected.

Where genetic factors are suspected, examination of siblings, parents and close relatives can be very informative. Genetic dental disorders which contribute to enamel defects are, however, relatively uncommon, and other local and systemic factors should also be considered.

In this young adult female, the slight translucency of the incisal edges can be seen clearly.

The teeth of this young male have sharper, less rounded contours.

Note the natural warmth of the enamel shade in this female teenager.

In this middle aged female, the translucency of the incisal edges is increased by wear on the palatal aspects of the central incisors.

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Opaque white flecks and underlying opacity.

The teeth have a generalized opacity. The incisal edges are not translucent.

The teeth show horizontal flecks, with more dense areas of opacity near the incisal edges.

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How to identify mild fluorosis

The typical appearance of mild fluorosis is small white opaque flecks, which are more visible near the incisal edges of the anterior teeth, superimposed on a general lack of translucency. Closer examination, however, reveals that all teeth are affected, not only the incisors. This pattern is generally more obvious when the teeth have been dried and isolated from the soft tissues. In cases of very mild or questionable fluorosis, the areas of white flecking and the underlying opacity and lack of translucency may not be visible until the teeth are dried and examined by a dental professional. These enamel changes would not be visible to the untrained eye at normal conversational distances.

As the occurrence of mild fluorosis has been linked to injudicious use of supplemental forms of fluoride, many countries have modified fluoride supplementation in the past decade in order to address this concern.

TREATMENT OPTIONS

Conventional treatments such as enamel microabrasion (etching followed by gentle abrasion with pumice) only affect the surface, and will improve the surface, but not the subsurface. Regeneration of the subsurface, using GC Tooth Mousse immediately after microabrasion, can address the underlying opacity and maximize the aesthetic benefit of treatment.

BEFORE

Mild fluorosis, immediately before treatment.

AFTER

After microabrasion and Tooth Mousse, the opacities are no longer present.

Intense horizontal banding and underlying opacity, before treatment.

After home use of Tooth Mousse, with a normal enamel appearance.

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TREATMENT OPTIONS

The clinical protocol is to isolate the teeth and undertake a two minute etch with 37% orthophosphoric acid gel. Then rinse and gently pumice each labial tooth surface for 20 seconds. The effect is then reviewed, and the etch/abrade cycle repeated as needed (often twice). GC Tooth Mousse is applied immediately and then each night at home before bed. The patient should be reviewed after four weeks.

How to identify moderate fluorosis

In cases of moderate fluorosis, the disturbances to enamel mineralization result in porosity and, over a period of time following eruption, stains can be taken up and trapped within the enamel, making these areas more obvious. There is a range of dietary chromogenic substances which can be taken up and retained within the superficial enamel giving these areas a more discoloured appearance.

Thus, it is not uncommon for the teeth to erupt with porous white opaque areas which then become discoloured over time. Discolouration can also occur pre-eruptively, but in most cases it becomes more obvious following eruption of the teeth.

Moderate fluorosis with intense areas of opacity. A small area of enamel surface loss has occurred on the left maxillary central incisor.

The teeth are opaque, and small areas of surface loss are present on several teeth, with shallow defects.

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TREATMENT OPTIONS

Moderate fluorosis requires two or three abrasion cycles at the initial appointment, followed by Tooth Mousse application. The patient should apply a pea size amount of Tooth Mousse each evening onto the treated labial enamel surfaces. At the four week review appointment, further etch/abrade treatments can be undertaken. These will greatly accelerate the subsurface regeneration effect of the Recaldent® CPP-ACP, and will also smooth the irregular enamel surface and improve the reflection of light.

Dr. Ken Tan

Moderate fluorosis, with small areas of enamel surface loss on all the incisor teeth.

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More noticeable changes have occurred on the maxillary teeth. The opacities become more apparent as the teeth lose moisture when isolated and dried.

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Hypomineralized areas have taken up exogenous stains, appearing brown. These stains are trapped in the outermost enamel surface and can be removed by mechanical abrasion.

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The irregular enamel surface is caused by post-eruptive changes to the hypomineralized enamel.

Dr. David Cox

Yellow staining of the areas of post-eruptive enamel surface loss makes these more apparent.

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This close up shows exogenous stains from the diet that have become trapped into the dysmineralized enamel surface, after the teeth have erupted.

Intense opacity and obvious areas of surface loss can be seen. As in other cases, dietary stains tend to be taken up after post-eruptive surface changes. These become more intense over time.

Dramatic opacity, surface pitting and superficial discolouration have occurred following orthodontic treatment. Achieving a good quality long lasting etch of this enamel can be challenging.

The irregular appearance of the opaque enamel is striking. Some areas of surface loss have required restoration with composite resin.

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How to identify severe fluorosis

In more severe forms of fluorosis, the impact on the physical properties of the enamel is more dramatic. A common sequel to this problem is that at various times following eruption, small areas of the enamel surface are lost spontaneously, giving the appearance of enamel hypoplasia. This results in the enamel looking as if it has not formed. However, in most cases, the physical defects occur following eruption of the teeth. Typically, where the matrix has been affected, the associated porosity allows more intense uptake of stained material from the diet and the environment.

TREATMENT OPTIONS

Treatment for severe fluorosis will normally involve several complete treatment cycles, spread over three months or more, with one treatment cycle per month as a recommended maximum. Areas of marked enamel loss which remain will require conservative restoration with composite resin, to achieve a smooth enamel surface.

Pre-treatment view. The patient had presented seeking an aesthetic improvement. The combined microabrasion/Tooth Mousse treatment approach not only conserves but improves the quality of tooth structure. It is time and cost-efficient, and well accepted by patients.

After three treatment cycles and nightly use of Tooth Mousse, there has been a dramatic improvement in the patient's appearance. The surface polishing has smoothed the irregular surface and removed the extrinsic stains, while the Recaldent® CPP-ACP has regenerated the subsurface enamel to give a pleasing normal appearance.

Well demarcated opacities on the labial surface, due to an injury or infection of the deciduous anterior teeth, which has affected mineralization of the permanent incisor teeth.

Opacities on the labial surface of the central incisor teeth, also due to injury to the deciduous precursors. There was intrusion of the deciduous incisors after a fall.

Porous hypomineralized enamel on the maxillary incisor teeth has taken up exogenous stains, becoming discoloured over time.

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How to identify enamel hypomineralization

There are multiple causes of enamel hypomineralization. The most common causes include perinatal problems, premature birth, low birth weight, chronic infections and febrile episodes in infancy, and trauma to permanent teeth or infection of their deciduous predecessors. Ameloblasts are highly sensitive to temperature changes, and there is an increasing appreciation of the association between elevated temperatures and changes in ameloblast function. These changes can result in altered deposition of enamel matrix, or, more commonly, the mineralization of that matrix – thus both hypolasia and hypomineralization can be a clinical sequel of such fevers.

A common cause of elevated body temperature in early childhood (at the time when the enamel of the permanent incisor teeth is forming) is chronic middle ear infection. Occasionally, clinicians attribute enamel formational problems to the antibiotics which may be used to treat such infections. However, given the high level of awareness regarding tetracyclines and their effects on teeth, and the common use of beta lactams and macrolides to treat middle ear infections, it seems more appropriate to attribute the clinical problem of enamel hypomineralization to the elevated temperature rather than to the antibiotic used to treat the underlying infection.

A classic feature of enamel hypomineralization is that the defects are very well demarcated and affect few teeth, unlike those in fluorosis which tend to have diffuse boundaries and affect many teeth. In enamel hypomineralization, relatively few teeth can be affected, and the defects are well defined. Generally when deciduous teeth have been affected, the defect only occurs on the labial aspects of the permanent incisor teeth.

There are multiple causes of hypomineralization.

Poorly demarcated areas of enamel hypomineralization on the labial surface of the maxillary central incisors.

Small, well demarcated areas of enamel hypomineralization. A large area is present on the right maxillary central incisor.

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A well demarcated defect with intense opacity on the right lateral incisor.

The right incisor has a well demarcated central region of opacity, and an outer area which is more diffuse and superficial. This will respond well to treatment, unlike the additional defect which will involve a greater depth of the enamel structure.

Localized areas of hypomineralization in the incisal thirds which have taken up stains progressively over time.

Poorly demarcated areas of opacity, which are ideally suited to conservative treatment using Tooth Mousse containing Recaldent® CPP-ACP.

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How to treat enamel hypomineralization

Poorly demarcated defects will be shallower and thus more amenable to the diffusion process which underpins subsurface regeneration with Recaldent® CPP-ACP. The surfaces must be treated to increase their porosity, before applying GC Tooth Mousse. A short enamel etch treatment (15-30 seconds) will suffice in patients who have not had optimal systemic fluoride exposure. Tooth Mousse should be applied immediately after treatment, and then each night before sleeping. As with fluorosis, the patient should be reviewed in 4-6 weeks, and the treatment cycle repeated as necessary to obtain the desired result.

TREATMENT OPTIONS

It is important to understand that cases with well demarcated opacities are not indicated for treatment with Tooth Mousse, as their depth precludes effective penetration by Recaldent® CPP-ACP.

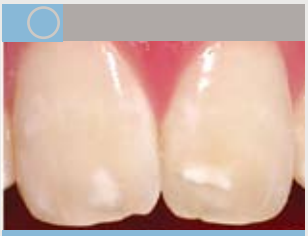
BEFORE

Pre-treatment view, after isolating the teeth.

AFTER

After initial surface treatment by acid etching, and use of Tooth Mousse at home, a dramatic improvement can be seen at the first review appointment.

A close up view of hypomineralization on these upper incisors prior to treatment.



At review, the hypomineralized area (left central incisor) has reduced in size. The outer diffuse area (right central incisor) has almost disappeared. The remaining areas are deeper in the enamel and will respond slowly or poorly to additional treatment cycles.

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Febrile episodes in childhood were the cause of the enamel hypoplasia and dysmineralization.

This close up view shows the defect on the left central incisor. Staining of the porous enamel at the base of the defect gives this area a darker appearance.

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In this case, the stepped appearance of defects can be seen, which involve the middle third of the maxillary lateral incisors, the gingival third of the maxillary and mandibular canines, and the cusp tips of the maxillary and mandibular first premolars.

How to identify hypoplasia

The distinction between hypoplasia and hypomineralization is important. In the latter, there is a change in the translucency of the enamel surface, such that it becomes white, cream, yellow or brown, but the enamel surface is smooth and the thickness of the enamel itself is normal.

Where hypoplasia is seen, more careful history taking is important. Hypoplasia, a quantitative defect of the enamel, may occur in several forms including grooves, as well as individual pits or rows of pits.

Patients who present with enamel hypoplasia generally have other areas of enamel which show disturbed mineralization. In cases where there have been major interferences in enamel formation, for example from anti-neoplastic chemotherapy, notches may occur in the enamel surface. Similar interruptions will occur in root formation for teeth at a more advanced stage of development.

In enamel hypoplasia, interruptions in enamel formation result in surface defects, which correspond to the chronology of the aetiological factor, e.g. a severe childhood infection, or febrile episode. Hypoplastic defects will occur on several teeth according to the pattern of their development, giving a banded or stepped appearance.

TREATMENT OPTIONS

Areas of hypoplasia are an imperfect substrate for bonding adhesive dental restorative materials, and these areas should be treated topically with a twice daily application GC Tooth Mousse for at least two weeks prior to their restoration.

Extrinsic staining

Changes in the structure of the enamel must be differentiated from extrinsic stains which develop in most individuals as part of their normal lifestyle. Areas of enamel which have enhanced porosity will tend to take up and trap these stains, and areas which have poor access to conventional toothbrushing, and where the surface texture is rough, will be more likely to trap and retain such stains making them more visible to the naked eye.

How to treat extrinsic staining

The clinician should attempt to determine whether the staining, which is present on the teeth, is a normal post-eruptive and extrinsic stain from dietary components such as tannins which contain polyphenols, or acquired pre-eruptively in association with a local or a systemic disturbance to tooth formation.

Removal of surface stains is an important pre-treatment before using subsurface regeneration approaches with Tooth Mousse, since surface stains provide a diffusion barrier to ions. Tars from smoking are particularly strong barriers in this regard. However, tannins from tea, coffee, wine and other beverages also act to physically impair the movement of ions across the surface of the enamel into the subsurface.

Extrinsic stain which has become trapped in an area where the enamel surface has microscopic irregularities.

These irregularities protect the stained material from the abrasive action of particles in toothpastes. A similar effect explains why extrinsic staining is more of a problem in interdental regions where there is no access to toothbrushing.

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This close up shows exogenous stains from the diet that have become trapped into the dysmineralized enamel surface, after the teeth have erupted.

Organic acids generated by thick dense plaque deposits produced white spot lesions.

Once oral hygiene improves, gingival inflammation resolves, leaving the arrested white spots as an "enamel scar" forever.

Extensive cervical demineralization, at the end of hygiene care, with no gingival inflammation or visible plaque.

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Although the demineralized surface was not cavitated, the enamel is structurally weak due to accumulations of subsurface water.

White spot carious lesions

As dental plaque produces organic acids, leaching of enamel mineral can occur, and the replacement of this mineral by water leads to changes in the refractive index of the enamel surface and subsurface. The altered scattering of light makes these areas appear white.

Enamel defects are more obvious when the teeth are dried (similar to other defect areas) since drying heightens the difference in refractive index between sound enamel and adjacent abnormal enamel. Common locations for white spot lesions are buccal surfaces beneath thick deposits of plaque and around the perimeter of orthodontic brackets where access for oral hygiene is impaired.

Because cavitation of white spot lesions on smooth surfaces does not typically occur until a considerable volume of the enamel mineral has been lost, white spot areas can extend broadly over the surfaces of teeth. If high concentration fluoride products are applied repeatedly to these lesions, the formation of calcium fluoride compounds can block any surface porosities, and this will result in these areas being effectively frozen in time for the life of the patient.

As well as on labial, buccal and lingual smooth surfaces, white spot lesions occur on proximal surfaces and also on the lateral walls of fissures. However, in these locations, they are much more difficult to see and are often overlooked.

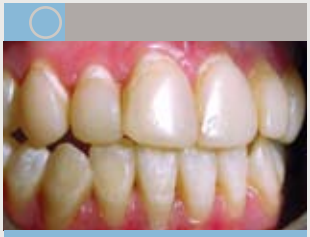
The distinction between white spot lesions and other areas of altered enamel can be made simply on clinical grounds because of the association of these lesions with areas of mature plaque, either at the time of the examination or

previously. White spot lesions which appear to be slightly supragingival, and where the gingival tissue is healthy, may indicate patients who have undergone demineralization, before then improving their oral hygiene, removing the plaque and allowing saliva to access the surface of the lesions.

BEFORE

Initial clinical appearance of demineralized enamel. All the teeth were affected. The upper teeth had been veneered with composite resin.

AFTER



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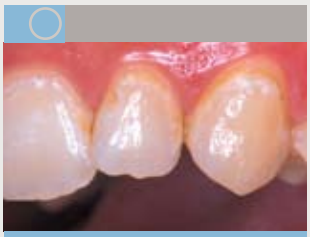
After an etching step to ensure lack of pellicle and maximum potential for diffusion, GC Tooth Mousse was applied each night to the mandibular anterior teeth. The reversal of the white spot lesions can be seen clearly in this post-treatment view, taken after three months.

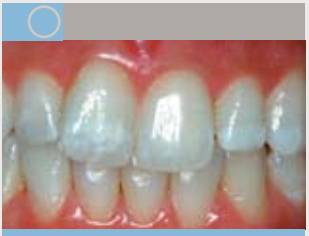


Demineralization is a common occurrence during fixed orthodontic treatment, because of microbial changes which increase the cariogenic potential of dental plaque. These lesions can be seen once the brackets are removed.

Dr. H. Hayashi (Japan)

Three months after daily treatment with the original 5% CPP-ACP trial material. The lesions are less noticeable since subsurface remineralization has occurred.

White spots from overbleaching



Dr. Mike Kallas

An example of over-bleached maxillary anterior teeth.

Excessive use of home or in-office bleaching products can result in opacity of the teeth, since the reactive oxygen species formed by bleaching products oxidize organic molecules. The destruction of enamel proteins and their replacement by water increases the overall level of water in the enamel subsurface, and this causes a change in optical appearance. While bleaching using products based on peroxides does not increase caries risk, it is important to appreciate that excessive use can affect the enamel subsurface appearance in a way which has some resemblance to dental caries in that subsurface water accumulates, and the physical properties of the enamel may be weaker. As with other enamel defects, isolation and drying of the teeth tend to make these defects much more obvious.

Identification of tetracycline discolouration

Tetracycline taken during the time of tooth formation will be incorporated into dentine and enamel. The same binding by calcium chelation occurs in bones as well as in teeth. Tetracyclines cause a range of discolourations from yellow to brown and grey. The colour depends on the particular tetracycline drug which has been used and the dose. With some tetracycline compounds, the intense effect on the enamel can lead to deterioration of physical properties and post eruptive loss of enamel giving the appearance of hypoplasia.

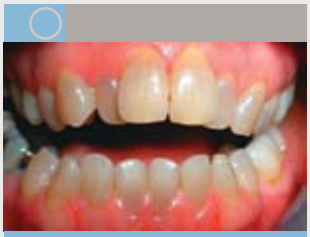
Because tetracycline forms a complex with tooth structure which does not respond particularly well to peroxide-based bleaching technologies, occasionally overbleaching of tetracycline stained teeth occurs because of injudicious treatment. Common patterns of tetracycline staining include the most mild

form where there is a uniform light yellow, brown or grey stain which is confined to the incisal three-quarters of the crown. In more severe forms, the teeth have an overall yellow, brown or grey stain without banding, and in the most severe forms, there is a dark brown, grey or blue stain which is intensely banded. These are the most difficult forms of tetracycline stain to treat from a cosmetic dental point of view.

BEFORE

Clinical situation before treatment, with intense banded discolouration from tetracycline antibiotics taken in early childhood.

AFTER



After laser whitening (Smartbleach™) with the DPSS-KTP laser.

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Tetracycline staining is typically resistant to most tooth whitening procedures, as the molecule which forms when tetracycline is incorporated into tooth structure is resistant to oxidation using peroxides. A specific photodynamic bleaching method (Smartbleach™) which employs intense green laser light has been shown to be effective in treating such cases, and useful improvements can be obtained with a single treatment session (3 cycles of 30 seconds of laser treatment per tooth). The treatment can be repeated to obtain further improvements in tooth shade. The images above show before and immediately after a single laser treatment session with Smartbleach™*.

References

Walsh LJ, Liu JY, Verheyen P. **Tooth discolouration and its treatment using KTP laser-assisted tooth whitening.** *Journal of Oral Laser Applications* 2004; 4 (1): 7-20

Verheyen P, Blum R, Walsh LJ. **Bleaching – accelerated with the laser.** In: *Oral Laser Application.* Moritz, A. (ed) Berlin: Quintessence, 2006. pp. 407-448.

*Smartbleach TM is a registered trademark of High Tech Laser Australia Pty Ltd.

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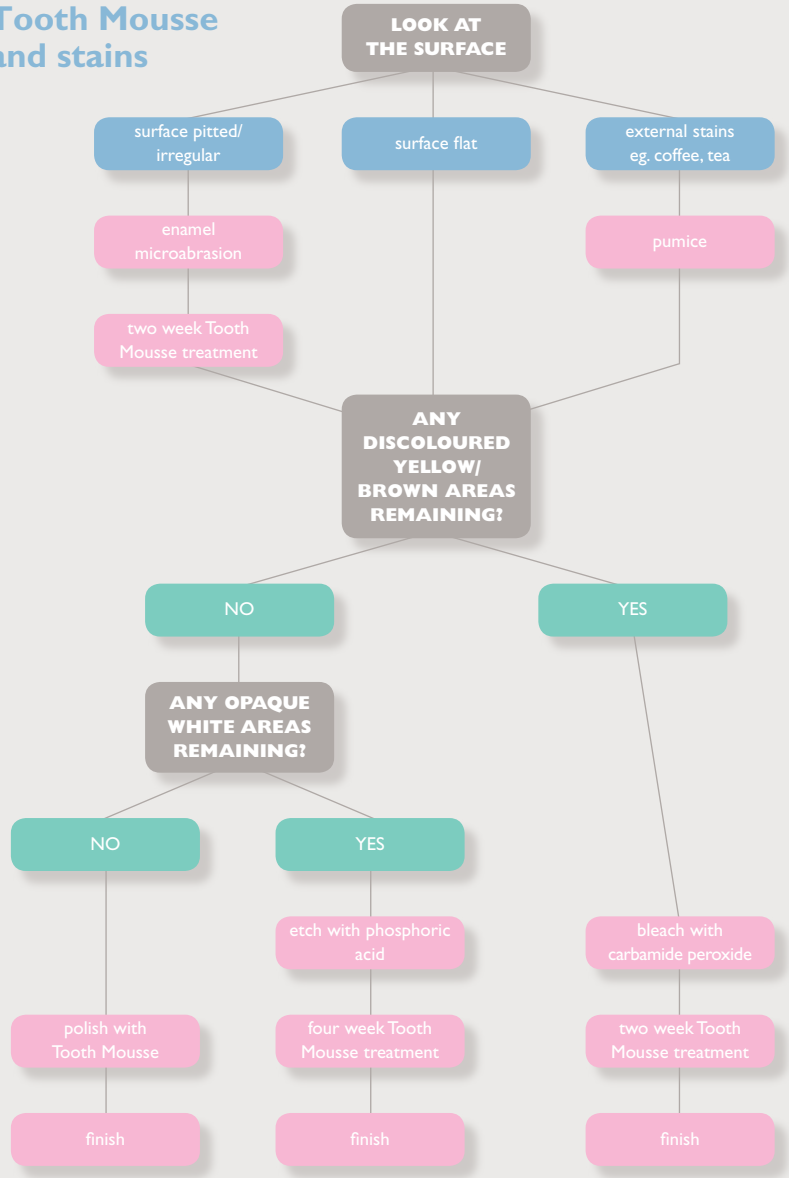
Tooth Mousse and stains



About the author

Laurence Walsh has been Professor of Dental Science at the University of Queensland since 1999, and has been Head of that School since 2004. In addition to his academic responsibilities, Laurence runs a part-time special needs dentistry clinic and serves as a dental adviser to the Australian government and to the dental industry. Laurence is well known for his work in the area of dental technologies, where he has been involved in the invention, development and evaluation of a range of dental products and technologies. He has lectured in more than 20 countries and has published extensively in dental literature. Laurence has played a substantial role in the development of clinical protocols for patient assessment, such as saliva tests and plaque tests, and has authored a range of education materials for clinicians as well as several textbooks and multimedia products. Through his own clinical practice over the past decade, he has developed and optimized clinical protocols for using GC Tooth Mousse for treating dental fluorosis, hypomineralization, white spots and other enamel lesions, and these protocols form the basis of the Tooth Mousse Portfolio series of publications from GC.

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