Figure 3A: Pre-operative clinical presentation reveals a resorbed edentulous mandible.

Figure 3B: A new mandibular denture is duplicated in a radioopaque resin (Biocryl-X; Great Lakes Orthodontics). The radioopaque template is subsequently used as a surgical guide.

Figure 3C: The prepared surgical guide should fit accurately on the residual alveolar ridge. The transparent guide must be oriented to the maxillary denture in centric relation.

Figure 3D: A monolithic zirconia prosthesis is milled from a copy of the denture (Zircon Zahn).

Figure 3E: An occlusal view of the prosthesis immediately following delivery reveals the planned orientation of the implants has been preserved and supports the design of the prosthesis.

Figure 3F: The screw access enables periodic removal for hygiene and evaluation of the implants and UniAbutments.
The impression: A blueprint to restorative success

The art and science of impression making was first described in 1755 when Philip Phaff proposed an impression technique using softened wax. The following 250 years evidenced numerous improvements in impression materials and clinical techniques. With the 1930s came the hydrocolloid materials (agar and alginate). The 1950s heralded a major breakthrough in synthetic elastomeric impression materials with polysulfides, commonly known as “rubber base” materials, which were primarily developed as an industrial sealant for gaps in concrete structures.

The sixties brought the polyethers while the seventies unveiled condensation and addition-reaction silicones. The last twenty five years have seen continued modifications in impression material chemistry, (ie, rendered hydrophilic addition-reaction silicones, advanced next generation polyethers), the development of dynamic mixing systems, improved impression techniques as well as a better understanding of the requirements for gingival tissue management.

The impression is the foundation and blueprint for restorative success with indirect restorations. The art of impression taking requires recording the exact dimensions of the tooth preparation, the precise position of the soft tissue, the architecture of the margins of the preparation, and the relationship of the prepared teeth to the surrounding teeth. Both restorative and periodontal complications can occur from improperly positioned subgingival margins, traumatic manipulation of the soft tissue, thin tissue biotype, and bulky fibrous papillae. Thus, an accurate final impression is the result of properly integrating multiple interrelated steps during the preparation and impression taking process since there are numerous areas where error could be introduced. This article reviews the preoperative considerations for soft tissue management prior to impression making and it examines the physical properties of the most commonly used impression materials. It also provides the criteria for the ideal impression. The description of a clinical procedure using the one-step/double-mix impression with a “double cord” gingival displacement is presented to provide the clinician with a step-by-step approach to successful final impressions.

Selection of Impression Material

All of the aforementioned impression materials have been evaluated in vitro and their properties have been well documented. However, an in vivo study is difficult to accomplish because of all the different variables (eg, blood and saliva contamination, deformation during tray removal). The following discussion will describe the clinically relevant physical properties that characterize the two most frequently preferred impression materials - polyvinyl siloxanes (PVS) and polyethers (PE). The most significant physical characteristics of these materials are...
Viscosity, hydrophilicity, setting time, tear resistance and elastic recovery, and dimensional stability.

**Viscosity**

The term “viscosity” describes the flow characteristics of an unset impression material. Materials with low viscosity have high flow and those with high viscosity have low flow.

The viscosity of the material increases with the proportion of filler present. Viscosity is affected by the shear force exerted on the material. The impression material can exhibit a decrease in viscosity in response to high shear stress and this is called shear thinning. Thus, the viscosity of the impression material will vary in accordance with the shear stress. The higher the viscosity of the material, the more evident is the effect of shear thinning. This phenomenon is believed to be due to the small filler particle size. The low viscosity material can be referred to as light body, syringe or wash material. These lower viscosity materials can flow easily into and record the fine details; however they are not usually used alone. They are used in conjunction with a second more viscous material to hydraulically propel and support the lower viscosity material.

**Hydrophilicity**

Impression materials are characterized by their degree of hydrophilicity. They may be hydrophilic, hydrophobic, or hydroactive. Surface wetting describes the relative affinity of a liquid for a solid and can be quantified by measuring the contact angle. A zero contact angle would indicate complete wetting of the surface whereas, a high angle would indicate less wetting. Moisture compatibility significantly impacts on the material’s ability to accurately record surface detail in the intraoral environment. Hydrophilic materials have a high affinity for moisture (low contact angle), provide good surface wetting and allow for a high degree of surface detail. Hydrophobic impression materials have a low affinity for moisture (high contact angle), provide poor surface wetting and a lower degree of surface detail. Hydroactive impression materials are impression materials that are normally hydrophobic and are rendered hydrophilic through the addition of surfactants. These materials provide excellent surface wetting (low contact angle) as well as a high degree of surface detail. However, it is necessary when discussing the wetting capability of impression materials to consider the materials’ wetting ability to soft and hard tissues and also to a gypsum slurry.

**Setting Time**

The setting time for an impression material is the total time from the start of the mix until the impression material has completely set and can be removed from the oral cavity without distortion. The working time is measured from the start of the mix until the material can no longer be manipulated without introducing distortion or inaccuracy in the final impression. The impression material must be completely mixed and seated in position before the end of the working time. Elastomeric impression materials have a working time of approximately 2 minutes and a setting time of between 2 and 6 minutes (i.e. fast and regular set). Generally, the working time corresponds to the setting time. Consequently, a fast-setting material will usually have a short working time and a slow-setting material will have a long working time. The setting time of all elastomeric impression materials is affected by temperature.
Tear Resistance and Elastic Recovery

Impression materials should have adequate strength to allow removal without tearing. A material with a higher tear energy provides resistance to tear for the impression. Elasticity allows the material to resist tearing and recover to its original prestressed configuration. The degree to which this occurs is a measure of the elastic recovery of the material. Permanent deformation can occur when the polymer is elongated beyond the point where elastic recovery is possible. It is desirable that an impression material should tear rather than deform past this critical point particularly in areas such as the margin of the tooth preparation. Permanent deformation is related to the degree of cross-linking of the polymer strands, the temperature and the rate of the applied stress.

These two physical properties (tear resistance and elastic recovery) are important in preserving the accuracy of the impression during intraoral removal and after cast separation. Materials with sufficient tear resistance and elastic recovery will withstand multiple pours, producing several accurate casts. This is a major advantage in contemporary restorative dentistry.

Dimensional stability

An impression’s ability to accurately replicate the intraoral structures is dependent upon its dimensional stability. The reasons for dimensional changes in elastomeric impression materials include the following: contraction due to reduction in spatial volume following polymerization, reduction in set volume from liberation of by-product or accelerator components, water absorption from wet or varying humidity environments and changes in temperature. Materials with sufficient dimensional stability can remain unchanged for a reasonably prolonged period of time (7 days), and resist temperature extremes during shipping while retaining the ability to produce multiple accurate casts.

There are several factors that can influence the required working time for impression taking. These are: the number of preparations, utilization of automix or hand-mix material, the viscosity of the material. The time required between mixing the impression material, syringing the material around the preparations and seating the tray are influenced by these factors.

Method for extending the working time is to refrigerate the materials before mixing with increases of up to 90 seconds having been reported when the materials were chilled to 2°C. However, chilling the material should be undertaken with caution when using automix tips or dynamic mixing units. Furthermore, lowering the temperature of the material below 65 degrees F will affect the flow of the pastes and result in altered base/catalyst ratios. Other factors that can influence the setting and working time include humidity, base to catalyst ratio, and the manner in which the material was mixed. In addition, extending the insertion time to ensure that the material has completely polymerized has indicated improvement in elastic recovery with decreased permanent deformation.

There are several factors that can influence the required working time for impression taking. These are: the number of preparations, utilization of automix or hand-mix material, the viscosity of the material. The time required between mixing the impression material, syringing the material around the preparations and seating the tray are influenced by these factors.

Figure 3 a, b: A primary compression cord of small diameter is placed using a periodontal probe and cord packing instrument to facilitate insertion with low force.

Terry et al.

Polyethers have played a successful role in clinical dentistry. The advantages for their use include low polymerization shrinkage, long-term dimensional stability, the possibility to generate multiple accurate casts, hydrophilic and highly accurate surface detail, elastic recovery, minimal distortion on removal, adequate tear strength, and good shelf life. They have the ability to...
The disadvantages include an unpleasant taste and odor, they tend to be very rigid and they set to a stiff consistency, there is difficulty with intraoral removal and cast separation. In addition, they are expensive and will absorb water if left immersed in disinfectants for long periods. Disinfection with glutaraldehyde for 10 minutes is recommended. Polyethers include Impregum F/Penta (3M-ESPE), Permdyne (3M-ESPE), Polygel NF (Dentsply Caulk), P2 (Heraeus Kulzer).

Addition reaction silicones, also known as polyvinyl siloxanes (VPS), constitute the most popular category of impression material. These materials are available in different viscosities to accommodate different impression techniques. The advantages for their use include their extremely high accuracy, they exhibit superior tear resistance, less polymerization shrinkage and increased dimensional stability, they have an neutral odor and taste, they permit multiple accurate casts, they are less rigid than polyethers on setting, and their tear strength varies with filler rates and viscosities. Their working times can be increased with chemical retarders, although temperature control of working time is the preferred method. They also exhibit excellent elastic recovery and possess the lowest distortion characteristics of any impression material. They can be used with all impression techniques providing fast setting times. They are extremely stable having a long shelf life and are easily disinfected in any solution without loss of accuracy, and they remain dimensionally stable for up to 7 days. The disadvantages include their inherent hydrophobic nature, and their susceptibility to inadequate polymerization as a result of latex contamination. The hydrogen gas release in some materials that may be responsible for generating bubble formation in the final model has been controlled with the addition of a scavenger in all contemporary polyvinyl siloxane materials.

Polyvinyl silicones include Flexitime (Heraeus Kulzer), Aquasil (Dentsply/Caulk), Splash! (Discus), Virtual (Ivoclar Vivadent)

Criteria for an Ideal Impression
An accurate impression is the key to restorative success. An ideal impression should provide the following:
1. adequate wash thickness to withstand distortion and tearing when removed intraorally
2. no evidence of voids, bubbles, drags or tears,
3. the ability to achieve a uniform and homogenous mix of materials,
4. uniform bond between the impression material, adhesive and tray, (Figure 01)
5. fine surface details free from debris such as saliva and blood,
6. distortion free, and complete set upon removal.

The “ideal impression” results from the integration of numerous factors. These are: proper material selection, tray selection, volume of material, timing, hemostasis,
materials may not lead to clinical success but accuracy of the impression may be controlled by technique. 8,12,47-50

Tissue Management
Healthy periodontal tissues are essential for the success of the impression-taking procedure. Inflammation of gingival tissues prior to impression taking can complicate the procedure. Bleeding and moisture from crevicular fluid can displace impression material and may result in voids and rounded indistinct finish lines that could cause an inaccurate cast and inadequately fitting final restorations. Furthermore, if a subgingival margin is placed in the presence of inflammation there is a potential risk of gingival recession and exposure of the restorative finish line. 8,51 Therefore, a fundamental requirement for achieving excellence in impression taking is management of the soft tissues.

The major preoperative consideration during initial therapy is the control and elimination of all sources of irritation and inflammation. This can be accomplished by control of plaque and the correction of restorative contributing factors. 25 Unfortunately, this may require delaying the impression procedure after tooth preparation to allow for improvement in the soft tissues. The provisional restoration is an essential component of this initial therapy and can improve the quality of the final impression. It preserves the position, form, and color of the gingiva and maintains the periodontal health prior to impression taking and while the definitive restoration is being fabricated. 52

Management of soft tissue during the preparation and impression taking stages requires a thorough understanding of gingival tissue architecture. The most important determining factor in predicting tissue response to preparation and impression techniques is the relationship of the free gingival margin to the osseous crest. Preoperative recordings of facial and interproximal bone height and determination and preservation of the biologic width can provide predictability into the post-restorative gingival margin levels and the periodontal health. 11

Clinical Impression Technique
Precise reproduction of the surrounding soft tissues in the final impression is essential since it assists the laboratory technician in developing optimal tooth shape and contour. (Figure 02) The following clinical procedure illustrates the one-step/double-mix impression with a “double cord” gingival displacement. During the diagnostic phase and prior to the restorative appointment...
the osseous crest position is determined on the facial and interproximal regions of the tooth to be prepared. The recorded numbers indicate a normal osseous crest.

During the restorative phase and after the onset of anesthesia, the tooth is prepared relative to the osseous crest with the finish line following the scallop of the gingiva. A primary compression cord of small diameter (3-0 surgical silk suture, Ethicon, Somerville, NJ) is soaked in plain buffered aluminum chloride and gently placed in the bottom of the sulcus around the preparation with light pressure from a cord packing instrument (Fischer ‘s Ultrapak #170, Ultradent, South Jordan) using a bimanual technique. This technique combines a periodontal probe and cord packing instrument to facilitate insertion with low force. (Figure 3 a,b) The finish line of the preparation is extended to the coronal aspect of the cord, which places the finish line of the final restoration approximately 0.5mm to 1mm below the gingiva. This initial placement of the retraction cord provides a seal to the sulcus to prevent contamination of the margins by blood or crevicular fluid. The first cord layer is a sulcus liner, to prevent tearing of the sulcular epithelium and bleeding when the second cord is removed immediately prior to injecting the impression material. This could be a problem with the single cord technique. In addition, the cord retracts the tissue so as to prevent contact of the diamond bur with the gingival epithelium during final margin placement.” (Figure 4) A second retraction cord (#2) is then inserted into the entrance of the sulcus using the same technique. (Figure 5) The tissue is now displaced apically and laterally. The gingival retraction is allowed to continue for 5 to 10 minutes to allow water absorption by the superficial cord. This generates expansion of the superficial cord and increases the crevicular width. (Figure 6 a, b, c) Prior to taking the impression, any excess moisture is eliminated and the patient participates in isolation using lip retractors. The second retraction cord is removed, and a low viscosity impression material is immediately injected into the sulcus. The entire preparation is covered with the low viscosity material and directly followed by the placement of the tray, which has been loaded with a more viscous material. The tray is removed along the path of insertion after inspection of the set material and the specified setting time has been reached. The impression is examined for accuracy with magnification. The ideal registration is created with a laterally deflected sulcus greater than 0.5mm in width with 0.5mm of apical deflection being sufficient to record an adequate amount of unprepared tooth structure apical to the margin. (Figure 7 a, b, c)
Conclusion
Restorative success is defined by the quality of the impression. The impression process requires an integration of various elements of restorative dentistry. The restorative dentist must have a knowledge of the physical properties of these materials and their application in a variety of indirect procedures in prosthodontics and restorative dentistry. However, various studies indicate that the accuracy of the impression may be controlled more by the technique than the material. Therefore this knowledge must be integrated with the proper technique for each clinical situation. Consequently, the ultimate success of the final impression depends on the skill of the operator and the experience acquired with that given technique.

References
Dental anxiety: causes, complications and management approaches

Raghad Hmud, Laurence J. Walsh

Introduction
Over recent decades, the everyday clinical practice of dentistry has benefited from major advances in techniques, technologies and materials, as well as in infection control procedures. At the same time, public awareness of oral health has improved. Despite these gains, anxiety related to the dental environment and to specific dental treatments is a problem suffered by many patients worldwide, and it remains a significant challenge in providing dental care. Whereas anxiety is an emotional state that helps normal individuals defend themselves against a variety of threats, anxiety disorders are a dysregulation of these normal defensive mechanisms, with either excessive or deficient responses. The purpose of this paper is to highlight clinical factors which can be addressed to reduce anxiety levels in dental patients.

Prevalence of dental anxiety
Dental anxiety has been ranked fifth among commonly feared situations. Given its high prevalence, it is not unexpected that patients with dental anxiety avoid dental visits. Only a minority of patients claim to have no anxiety in the dental environment. A study conducted in Holland reported that only 14% of the Dutch population experienced no apprehension or anxiety when visiting a dentist, whilst almost 40% experienced “more than average” anxiety, and 22% were “highly anxious”. In this study, the patients most likely to experience high levels of dental anxiety were women aged 26-35 years who were irregular attenders. In Australia, published data from 1996 reveal that some 14.9% of adults could be classified as “highly dental anxious”. Once again, there was a greater prevalence and severity of dental anxiety in women than men, particularly in the 35-44 age range. A more recent study by Armfield et al. confirmed these data, with a population prevalence for dental fear of 16.4% for adults and 10.3% for children, yielding an overall prevalence of 16.1%. Other studies internationally have reported a prevalence of between 5 and 20%, with a recent estimate of 6-15% globally for patients who avoid dental care because of high levels of dental anxiety and dental phobia.

Many cross-sectional studies have documented that the prevalence of dental anxiety reduces with age, and this has been confirmed in a longitudinal study conducted by Hagglin et al. which followed individuals from 1969 to 1996. Similar declines in other general and specific phobias with age were also found in this study. Few studies have not found a strong association of dental anxiety with age.

In relation to gender, the large majority of studies have found higher prevalence rates for dental anxiety in females than males, and this has been confirmed in a longitudinal study conducted by Hagglin et al. which followed individuals from 1969 to 1996. Similar declines in other general and specific phobias with age were also found in this study. Few studies have not found a strong association of dental anxiety with age.

The relationships between dental anxiety and other demographic variables such as income level and education (socioeconomic status) have not been fully elucidated. While some studies have demonstrated that higher levels of dental anxiety are associated with low income and education, other have failed to find such relationships. Taken in combination with other variables, it would be expected that being female, having a low income, and having a low perception of one’s oral health status would be linked with higher levels of dental anxiety, and this combination has been confirmed in a study by Doerr et al.

Causes
Dental anxiety is a multidimensional complex phenomenon, and no one single variable can account...
Within the literature, there are a number of factors that have consistently been linked with a greater incidence of dental anxiety, including:

- personality characteristics,
- fear of pain,
- past traumatic dental experiences, particularly in childhood (conditioning experiences),
- the influence of dentally anxious family members or peers which elicit fear in a person (vicarious learning), and
- blood-injury fears.8,14-19

Fear of pain has been linked strongly to the development of dental anxiety and to avoidance of dental treatment.17,18 Studies by Kent indicate that memory of dental pain is “reconstructed” over time. He found that highly anxious patients tended to overestimate the pain they would feel prior to dental procedures, and also overestimate the pain experienced, when asked to recall it later.20,21 This pattern of findings has also been seen in other studies.18,22,23 For example, in a study by Arntz et al. which examined 40 dental patients who twice underwent oral surgery, the highly anxious patients expected more pain than they actually experienced during the procedure, and also required more time for chairside management than did patients with low levels of anxiety.23

Several studies have shown that restorative dentistry procedures deliver the most potent triggers for dental anxiety, namely the sight, sound and vibrational sensation of rotary dental drills,14, 24, 25 coupled with the sight and sensation of a dental local anaesthetic injection.14,25,26

It is for this reason that anxious patients who must undergo restorative procedures are often managed using the “4 S” rule, which aims to reduce the triggers of stress:

- Sights (e.g. needles, drills)
- Sounds (drilling)
- Sensations (high frequency vibrations – with a high annoyance factor)
- Smells (clinical odours, such as eugenol and bonding agents) using alternative methods such as
- atraumatic restorative technique (ART)
In general terms, a patient's expectation of experiencing pain, being hurt and choking or gagging during treatment can act as a major trigger for dental anxiety. As will be discussed later, addressing these points can have powerful preventive effects.

It is important to recognize that as well as the "4 S" anxiety triggers, there are a number of other factors which can trigger anxiety or increase it. Aspects of dentist-patient interactions are particularly important here. Triggers for dental anxiety can include statements made by the operator, in particular when they are angry or if they make condescending comments. A study by Moore et al. found that these types of negative dentist contact behaviours were 5-10 times more likely to be reported by highly anxious patients. Furthermore, dentally anxious patients have complained that dentists make them feel guilty for being anxious.

The period of time spent waiting for dental treatment is cited commonly by patients as being anxiety-provoking, as it increases the time to think about what will (or could) happen, and to ponder the worst-case outcomes. This emphasizes the need for support staff in the dental practice to be aware of an anxious patient, and to actively take measures to reduce their concerns. Negative feelings such as loss of control, and feeling vulnerable in the dental setting, are also cited by patients. Informed new patients (for example, using a brochure) that they can interrupt the operator during treatment, may overcome this "loss of control" fear, and has been shown to be effective in anxiety reduction. Many dentists use a simple signalling system (such as a raised hand) to give control to patients, and this has been shown to be particularly useful with children as well as with anxious adult patients.

**Consequences and complications**

Dental anxiety has been associated strongly with poor oral health status. Eitner et al., found that avoidance of dental treatment is highly correlated with anxiety scores and with increased caries morbidity and DMFS scores. Several studies have shown that highly anxious patients have a higher probability of irregular dental attendance and/or total avoidance of dental care. Higher dental anxiety scores have been documented amongst patients who have not visited a dentist for the last 5 years. Moore et al. found that patients with high levels of dental anxiety were more likely to not have sought dental care in the past two years, and were more likely to skip or cancel appointments or to hesitate in making dental appointments.

Even if anxious dental patients attend regular dental visits, they are likely to avoid necessary follow up appointments to complete the required dental treatment. This avoidance of dental treatment results in higher caries prevalence, leading to a greater need for oral rehabilitation. For example, Locker and Liddell found that dentally anxious patients had significantly more missing teeth and fewer filled teeth compared to non-anxious patients. A spiral situation can occur, where poor oral health and a patient's inability to accept dental treatment, leads to feelings of inferiority and shame, which in combination may lead to greater anxiety and further avoidance of dental care. The long term consequences for the dentition may explain why dental anxiety leads to increased use of general medical services for prescription of antibiotics and analgesics.

As well as affecting an individual patient's oral health status, dental anxiety may have a much wider impact on their life. Dental anxiety evokes physiological responses of the "fright or fight" type, and these can lead to feelings of exhaustion after a dental appointment. Cognitive impacts of dental anxiety include negative thoughts, fear, crying, aggression, sleep disturbances, disturbed eating habits, and greater self-medication. Impacts on social interactions, performance at work, self-esteem and confidence have also been reported.

Several studies have shown that highly anxious patients take longer to treat in the general dental practice setting. The incurred additional costs may be a significant determinant of whether people will have follow-up care, since private dental insurance arrangements are not generally supportive of the longer appointment times needed to provide care. It is not surprising, therefore, that some dentists perceive dentally anxious patients as being unreliable and a poor economic risk.

Other problems that dentists may encounter with anxious patients include reduced satisfaction with treatment planned or provided. Several studies have revealed a relationship between dental anxiety and satisfaction with the appearance of one's mouth. Highly anxious patients are more likely to be dissatisfied with the appearance of their teeth. They may also have a heightened expectation that the treatment will be unpleasant. As would be expected, a patient's attitude...
toward dentists has been shown to have an inverse linear relationship with dental anxiety, that is, more anxious patients were less positive about their dentist.\textsuperscript{13} Moreover, as patients’ perceptions of dentists’ competence decreased, their dental anxiety was found to increase.\textsuperscript{34}

**Management**

Nearly two thirds of dentists believe that treating an anxious patients presents a challenge to them in everyday practice.\textsuperscript{36} Identifying these patients and putting appropriate measures in place is therefore essential. Patients displaying behaviours such as frequent cancellation, delaying or rescheduling appointments may be doing so because of dental fear and anxiety.\textsuperscript{6} Upon identification of an anxious or fearful patient, a range of measures can be put into place, for example:

- allowing sufficient time for the dental appointment
- minimizing triggers, following the “4 S” principle described earlier, e.g. by altering the surgery set-up, the dental assistant can place instruments where they are blocked from view or covered\textsuperscript{35}, or could spray a scented oil fragrance to reduce the clinical aroma of the treatment room,
- introducing relaxation methods (see below),
- provision of extra control during the procedure,
- using distraction techniques, e.g. music via headphones, video glasses, and virtual reality glasses (especially for adults),
- providing more efficient anaesthesia, or using adjunctive methods, e.g. peristaltic injectors (Wand\textsuperscript{TM}), topical creams (EMLA\textsuperscript{TM}), and transcutaneous nerve stimulation
- referral to cognitive or behavioural specialists or psychologists for anxiety management and behaviour therapy\textsuperscript{6}
- Conscious sedation using pharmacological agents

Using a multifaceted approach rather than relying in one single strategy improves the likelihood of success. The management of anxious patients will vary depending on factors such as the patients’ age, anticipated degree of cooperation\textsuperscript{39}, and their medical and/or dental history.\textsuperscript{42}

Dentist behaviours targeted to anxiety reduction, such as having a calm manner, being friendly, giving moral support, being reassuring about pain, preventing pain, and working efficiently, have been shown to reduce anxiety.\textsuperscript{37}

**Communication**

Staff-patient communication with patients plays a very important role in anxiety reduction. Providing verbal support and reassurance is a frequently used strategy.\textsuperscript{35} To be maximally effective, this approach needs to be taken by all staff members with whom the patient interacts. A receptionist who notes anxious patients can schedule sufficient time for the appointment, allowing the clinical operators some additional time to carefully explain procedures, and then to proceeding slowly with treatment.

**Relaxation therapies**

Relaxation therapies can enhance trust and give patients the feeling of control over their psychological state. These methods can be very effective in motivated and cooperative patients, and can be used before and during a treatment appointment. These techniques are safe, have no side effects, and give patients more control over their anxiety level.

A common method is Jacobsen’s progressive muscular relaxation, which relaxes patients by reducing physical (muscle) tension, and makes them more aware of their stressed and aroused state, and how to address this. Their greater feeling of control over the situation and over their anxiety symptoms should translate into greater ability in coping with the stress of dental treatment. A simple scheme for progressive muscular relaxation involves tensing and relaxing groups of muscles in turn, for example from the feet through the lower body and abdomen to the thorax and then the head and neck.

Another simple method for promoting relaxation is paced breathing, where patients inhale using deep diaphragmatic breathing, hold for 5 seconds, then exhale over 5 seconds. This slow paced breathing can be combined with imagery-based methods with the use of particular words, visual images or thoughts that are linked with the breathing rhythm, for example using a cue word such as “CALM” on the exhalation cycle. With repeated practice, patients can move more quickly into the relaxed state.\textsuperscript{40}

Relaxation and breathing techniques have been used successfully with patients who are fearful of receiving dental treatments, and can be easily taught to patients and applied quickly in a dental environment.\textsuperscript{40}

**Distraction**

Virtual reality techniques which involve the use of coloured glasses to experience a three-dimensional computer-generated images during dental treatment, have been shown to engage and relax adults, but with less positive results for children.\textsuperscript{41} In other words, dental anxiety in children may respond to simpler types of...
distraction that do not require complex cognitive processing. Interestingly, studies of the levels of dental anxiety in children, both before and after dental treatment, show this to be (as in adults) higher among females than males. Children with high intelligence quotients tend to show less dental anxiety at their first dental visit. There does not, however, appear to be a strong relationship between a child’s anxiety and their own personality variables.42.

In adult patients, by using distraction and other anxiety reduction measures, with repeated positive experiences, a patient’s level of anxiety should reduce 43. For example, Marks et al. have reported that prolonged exposure to non-traumatic anxiety cues helps patients adapt to these situations and will diminish their excessive responses.1

Techniques with reduced annoyance factors
Restorative dentistry has, historically, had a strong association with both pre-treatment dental anxiety and fear of pain during treatment. The term “annoyance factor” refers to the patient’s subjective reaction to restorative dentistry procedures such as cavity preparation, and is a combination of the pressure applied to the tooth, the vibrations and noise recorded through the bones of the skull, the heat and smell generated at the interface between the tooth and the bur and the time taken to perform a given task. 44 New methods for restorative dentistry have reduced annoyance factors compared with conventional rotary instruments, and in so doing they help to eliminate or reduce a major trigger of dental anxiety. Atraumatic restorative technique (ART), air abrasion, chemo-mechanical caries removal (Carisolv™), and middle infrared lasers may now be considered alternative methods for tooth preparation and caries removal.

The erbium (Er:YAG and Er, Cr:YSGG) lasers act selectively on water present in hard tissues, because of their wavelengths and are able to ablate carious enamel and dentine. When used properly they may induce a depressed state of responsiveness in pulpal nociceptors.44 Generally, patients undergoing cavity preparation with erbium lasers do not need local anaesthesia. Large scale clinical trials report that only 2-5% of patients will request local anaesthesia although many patients experience slight, intermittent sensations of cold in their teeth, probably caused by the cooling effects of water evaporation during laser pulses. 40 Suppressive effects on nerve firing give an analgesic effect with a duration of 10-15 minutes. Use of this analgesic effect can maintain comfort in anxious patients, allowing treatment of several teeth, in one appointment, without the need for injected local anaesthesia.

The ART method has been used extensively in dentistry for conservative management of open cavitations in dentine. On the other hand, chemo-mechanical caries removal is a minimally invasive method which involves the selective removal of soft carious dentine without the painful removal of sound dentine during cavity preparation, as a form of chemically accelerated ART.

Use of these novel methods may be effectively targeted to anxious dental patients, where the different methods reduce the major stimuli for anxiety and also provide a distraction effect, thus giving overall a reduction in dental anxiety.24 If patients are aware of these methods, they may petition the dentist to use them for future dental treatment. A study by Eitner et al. found that 60% of the participants expected to be treated better if they described themselves as very anxious to the dentist.24

Sedation
Conscious sedation techniques have been proven to be reliable and safe for managing dental anxiety.38 while more severely anxious and uncooperative patients can be treated under general anaesthesia. Agents such as nitrous oxide and oxygen administered by inhalation are in common use, however for anxiolytic agents, a wide range of routes of administration exist, including ingestion, rectal suppository, intramuscular injection, and intravenous injection for direct application into the circulation, as in the case of midazolam, diazepam and other benzodiazepines.39 Agents used for sedation must produce a relaxed state rapidly for the period needed, but must then wear off rapidly so that the patient can return to their normal state.39

Clinical Scenario
A patient presented to a dental clinic for the treatment of two broken down but not painful maxillary molar teeth (16 and 17). After examination and discussion of treatment options, the patient agreed on full coverage porcelain-fused-to-metal crowns. The dentist booked the patient with plenty of time to complete crown preparation and temporization procedures. On the appointed day, the patient, looking calm and collected, was greeted curtly by the dentist (who was running a little late) and then seated in the dental chair. The dentist, without explaining the procedure or the steps involved, reclined the dental chair fully to the supine position, and began by trying alginate trays into the mouth. Alginate was then mixed by the assistant, and the maxillary tray inserted into mouth. The
patient, rather alarmed and feeling claustrophobic with a mouth full of dental impression material, began to panic, with difficulty in breathing, followed by gagging. He pulled the impression tray out of his mouth, and told the dentist that he did not want the treatment. After a brief but heated exchange between the patient and dentist, the patient stormed out of the clinic.

Case discussion
The patient was in a particularly nervous state at the start of this appointment, although he was anxious about having an unknown procedure. The lack of communication of the dentist at both the first and second visits is a critical factor, since the patient, without having had any dental impressions previously, did not know what to expect, and in particular how long the impression material would be in his mouth. With long procedures, having a clear understanding between the patient and the operator regarding “stopping points” is essential. In this case, the patient was not aware of the steps involved in the procedure, and lacked any control of his situation. This increased rapidly his level of anxiety. Lying in a supine position increases the impression of vulnerability and lack of control. The resultant anxiety was amplified by the patient’s concerns of airway compromise. To balance his mental state and to preserve his well-being, the patient decides to take control, and removes the impression tray.

The curt and unsympathetic response of the dentist is the final trigger for the irrevocable breakdown in their relationship. The patient will now, with other dentists, remember how unpleasant his previous impression experience was, and will have heightened anxiety for his future dental treatment. The unpleasant encounter in the dental surgery will resurface in his mind when the word dentist is mentioned in conversation, and this will reinforce his negative views of dentists and will consolidate his anxiety. The dentist has lost time and income. It is likely that the disgruntled patient will relate his story to acquaintances, which could have a negative effect on the dentist’s reputation because of the word-of-mouth downstream effects.

To prevent this scenario from occurring, the dentist should have had a discussion at the end of the first visit or the start of the second visit, about what the procedure involved. The patient could have been sat upright for the maxillary alginate impression, with appropriate coaching on slow timed breathing, particularly if this was the patient’s first impression. Reassurance by the dentist or chairside assistant during the impression taking procedure would have been of great benefit, and would have reinforced to the patient that the clinical staff have their wellbeing in mind. These simple steps would have eliminated the problem at its source.

Conclusion
Dental anxiety is a common problem found throughout the world, with approximately one in six adults suffering more severe forms of dental fear and anxiety. Sex and age appear to be important factors linked to dental anxiety, with females from 30-45 being particularly common within the dentally anxious group in the population.

Dental anxiety is a multidimensional complex phenomenon which is influenced by personality characteristics, fear of pain, past traumatic dental experiences in childhood, and dentally anxious family members or peers.

Severe dental anxiety is a major barrier to seeking professional dental care, and the implications of this in terms of dental disease are significant in terms of deterioration of their dentition, and a range of psychosocial problems. The management of the dentally anxious patients should involve considering both complementary and pharmacological means. Helping highly anxious patients to overcome their fear of dental treatment is a challenge, however if achieved it will result in improvement in their oral health and in their overall quality of life and wellbeing.

References
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