For some time, we have been benefiting from IPS e.max® CAD-on/Veneering Solutions (Ivoclar Vivadent), a working technique that combines lithium disilicate (LS2) and zirconium dioxide (ZrO2). In addition to IPS e.max ZirCAD and IPS e.max CAD blocks (Ivoclar Vivadent), the technique includes the use of a high-frequency vibrating device (Ivomix, Ivoclar Vivadent) and a special thixotropic fusion glass-ceramic to join both of the ceramic structures. In this case report, we will demonstrate how to implement the technique step by step in order to achieve natural-looking and functional restorative results.

In our case, the patient visited the dentist because she was unhappy about her maxillary anterior restoration. The ceramic material had flaked off at several sites and the function of the metal–ceramic bridge was impaired. Consequently, she wanted to have it replaced (Fig. 1).

A detailed examination of the clinical situation established that, owing to severe bone atrophy, teeth #11 and #21 were not suitable for anchoring a new dental prosthesis to them and that they would have to be extracted. Since the patient was unwilling to undergo augmentative procedures, placing an implant-retained prosthesis was not an option. Instead, we decided to install a fixed bridge that would be anchored to abutment teeth #14 and #12 on one side and to teeth #24 and #22 on the other side. The area surrounding teeth #11 and #21 would have to be reconstructed with artificial gingiva.

**Treatment procedure**

After removal of teeth #11 and #21, the extraction site was allowed to heal for a sufficient period (Fig. 2). Meanwhile, the technician fabricated a diagnostic temporary for evaluation of the aesthetic and functional parameters. In order to achieve a harmonious smile, the incisal edges of the anterior teeth had to be lengthened considerably (Figs. 3a & b).

During the try-in, the contour of the artificial gingiva was determined and shaped (Fig. 4). Based on the wax-up, the technician created a temporary that was allowed to heal for a sufficient period (Fig. 2). Meanwhile, the technician fabricated a diagnostic temporary for evaluation of the aesthetic and functional parameters. In order to achieve a harmonious smile, the incisal edges of the anterior teeth had to be lengthened considerably (Figs. 3a & b).
parameters, we joined the ZrO2 final stage. After checking the data into two sets for the prognostic measurements taken at the prescriptive stage, in-depth knowledge of the materials involved in the treatment process, and excellent collaboration led to a highly aesthetic result without the need for surgical intervention. The procedure ideally combines two outstanding materials and has proven to be both reliable and cost-effective.

Acknowledgement: This case was conducted in collaboration with dental technician Paolo Viganò and Dr. Leonardo Rarchimini from Florence. I would like to thank them both for their support.

Reference
Cone Beam Computed Tomography: Is dentistry ready for a new standard of care?

Dr Lee M. Whitesides
USA

Since its commercial introduction into dentistry in 2001, cone beam computed tomography (CBCT) has been rapidly evolving into a new standard of care in maxillofacial imaging. In just over a decade, CBCT has exploded onto the dental landscape and permitted dental professionals a degree of three-dimensional (3-D) anatomic truth in maxillofacial imaging previously unavailable and unattainable.

Like many other new technologies, which have progressed from the extraordinary to the ordinary and thus gained acceptance by professionals and patients, CBCT has advanced from exceptional use to almost commonplace use in dentistry as cost decreases, access to the technology increases, and potential adverse patient interaction (i.e. radiation exposure) is attenuated. Today, CBCT is seen by many in dentistry as the standard operating procedure for many dentistry, orthodontic, orthodontic, or endodontic cases.

The advancement of CBCT in dentistry has caught the attention of manufacturers of radiologic equipment. In 2001, only one company sold a CBCT system. In 2014 there are at least 20 companies selling CBCT machines and technology. Henry Schein, a leading distributor of dental equipment, has seen CBCT sales expand from 5 per cent of their digital imaging sales to almost 60 per cent of digital imaging sales in the last five years.

CBCT has also been recognised by general dentists and specialists as a means by which they can separate, identify, and distinguish their practices as being on the vanguard of technology in patient care. Today’s patients expect their dentist and physicians to be contemporary with technology and services. CBCT provides the doctor with a technology, which not only has significant advantages in treating patients but also has a noteworthy “wow” factor as the 3-D images are seen on a large screen in “real time” for the doctor and patient to view.

CBCT, like plain film radiographic studies, may be considered a revenue generator for a practice. The more a CBCT machine is utilised, the more revenue it will generate. Additionally, the owner may allow others in the profession to utilise the machine for a fee, thereby reducing its overall cost of operation.

Standard of care is a legal and medical concept. Standards are constantly evolving as methods and techniques in patient care improve. An appropriate definition for standard of care may include such language as: the dentist is under duty to use that degree of skill and care which is expected of a reasonably competent and prudent dentist under the same or similar circumstances. Standards of care may be local, regional or national.

Standard of care influences

The influence of an emerging technology, like CBCT, into a new standard of care involves many criteria. These criteria include:

- maintains that scientific evidence presented to the court must be interpreted by the court as “generally accepted” and expert testimony must be based on scientific methods that are sufficiently established and accepted.

In Frey, the court opined: “Just when a scientific principle or discovery crosses the line between the experimental and demonstrable stages is difficult to define. Somewhere in this twilight zone the evidential force of the technology, like CBCT, into a new standard of care must be sufficiently established and accepted.

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In Frey, the court opined: “Just when a scientific principle or discovery crosses the line between the experimental and demonstrable stages is difficult to define. Somewhere in this twilight zone the evidential force of the technology, like CBCT, has been tested and proven over many years of application in the medical and dental arena. The Housould unit is the widely recognised standard quantitatively for describing radiographic density and provides doctors with a known standard and error rate in computed tomography. The widespread acceptance of CBCT by the medical and dental community is demonstrated by the ever increasing presence in dental and medical practices of the technology. Additionally, The Intersocietal Accreditation Commission, an accreditation organisation for medical and dental imaging, has developed guidelines and accreditation criteria for 3-D CBCT imaging. Thus CBCT appears to have satisfied both the Frey and Daubent criteria for acceptance as a standard of care technology.

Not to discount the value of CBCT imaging or its ability to successfully satisfy the Frey or Daubent criteria, the absence of CBCT is not de facto evidence of lack of a standard of care imaging. Many patients present to their dentist with uncomplicated cases where traditional two-dimensional radiographic studies are appropriate and provide the dentist with standard of care imaging of the patient. For the more complicated cases, 3-D imaging may be employed to provide the dentist with superior anatomic evidence in treatment planning and diagnosis. Three-dimensional imaging with CBCT can also be used in uncomplicated cases, but it may not necessarily be considered the standard of care for every case in 2014.

Expert Testimony

An expert is a person with sufficient professional qualifications to render an opinion on the subject at hand. Not all experts are created equal, and in fact in three states (Iowa, South Dakota, and New Hampshire) an expert need only be qualified by test to offer an opinion. Experts are used by the courts to educate the judge and jury as to what constitutes normal minimal acceptable care of a patient in a given environment.

Expert testimony is by definition the opinion of one practitioner. It is an opinion based on fact, evidence, experience, and knowledge which the expert believes to be relevant, valid, and upheld in the scientific community.

When reviewing a case for suspected malpractice the expert examines many things, including, but not limited to, chart notes, radiographic studies, depositions, and professional correspondence. In recent years, the author has noticed a remarkable increase in the number of cases in which plaintiffs and defense attorneys, as well as experts, rely on pre and or post procedure CBCT imaging studies to assist in proving malpractice or defending good practice. Post-treatment radiographic imaging to prove malpractice or support good practice is not new to dentistry. In fact in the years preceding WWII, some of the highest malpractice claims were awarded in cases where post-treatment radiographs played a pivotal role.

Logic would dictate that if plaintiffs and defense counsel and experts are making CBCT part of their strategy, then CBCT must be not only prevalent and pertinent but of significant value in the formation of an opinion by an expert and/or at trial. When reviewing a case, CBCT can be seen as an additional and important factor that can help explain why the doctor did what he did or why an unfortunate outcome occurred. Additionally, CBCT provides powerful and easily understandable images for layperson jury.

Recognising the value that CBCT adds to a case does not necessarily indicate that CBCT is the standard of care in every case. The decision to obtain a CBCT study before the procedure is determined by the dentist based on his experience and knowledge of the case.

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To assess the influence of CBCT in the dental literature, the author performed a PubMed literature search in October for the words cone beam CT, cone beam CT + dental implants, cone beam CT + orthodontics, cone beam CT + oral surgery, cone beam CT + endodontics, cone beam CT + endodontics, cone beam CT + orthodontics, cone beam CT + orthodontics, cone beam CT + dental implants, cone beam CT + dental surgery, cone beam CT + oral surgery, cone beam CT + endodontics, cone beam CT + endodontics, cone beam CT + orthodontics, and cone beam CT + orthodontics in the search line. The results are in Table 1.

Evaluation of Table 1 data clearly shows a significant presence in the literature of articles pertaining to the use of CBCT in the various disciplines in dentistry. The vast majority of literature discovered pertains to addressing the use of CBCT in treatment planning and diagnosis of patients in dental implant therapy, oral and maxillofacial surgery, orthodontics, and endodontics. Articles on new applications of CBCT technology to patient care were also prevalent in the sample. Some articles addressed the risk and benefits of CBCT but none denounced CBCT as harmful to the patient or insignificant in treatment planning and diagnosis. Two similar PubMed reviews of the literature on CBCT were performed by authors Alamri et al (Applications of CBCT in dental practice: A review of the literature. Gen Dent 2012: 60(5): 390–400) and De Vos et al (Cone-beam computerized tomography (CBCT) imaging of the oral and maxillofacial region: A systematic review of the literature. Int J Oral Maxillofac Surg 2009;38: 609–625).

Both of these exhaustive articles demonstrate the plethora of literature addressing CBCT and its application in the many disciplines that require it.

### Professional Guidelines

For a technology such as CBCT to become a standard of care in dentistry, guidelines for its use and application in patient care must be established by the organisational bodies of those disciplines which independently employ the technology to treat patients. In dentistry, the dental practitioners most involved in the use and application of CBCT in patient care include general dentists, oral and maxillofacial surgeons, endodontists, oral and maxillofacial radiologists, orthodontists, and periodontists.

The American Dental Association has over 180,000 licensed dentists representing approximately 75 per cent of dentists in the USA. The American Dental Association published an advisory statement article in its principal journal, The Journal of the American Dental Association, in August 2012. The article discusses the many positive aspects of CBCT, but stops short of calling CBCT a new standard of care. Rather, the ADA encourages the dentist to use CBCT “selectively, as an adjunct to conventional radiography”. The ADA further recognises the value and presence of CBCT by including CBCT-related courses at its annual meetings and continuing education programmes during the year.

The American Association of Oral and Maxillofacial Surgery (AAOMS) has over 9,000 members representing approximately 95 per cent of oral and maxillofacial surgeons practising in the US. Literature addressing the application of CBCT in oral and maxillofacial surgery has been around since 2007. The AAOMS has offered continuing education in the use and application of CBCT for patient care as far back as 2011. The AAOMS has worked with the IAC to develop guidelines and accreditation criteria for 3-D CBCT imaging. In a recent survey of OMFS residency programmes, 87 per cent of programme directors acknowledged the use of CBCT in patient care by their residents.

The American Association of Endodontists (AAE) and the American Association of Oral and Maxillofacial Radiologists (AAOMR) have released a formal position paper on CBCT. This paper makes many important points, such as limiting the field of vision to minimise radiation exposure and increase resolution, careful patient selection in CBCT, and the responsibility of the clinician to interpret the entire image. The position paper goes on to declare “the use of CBCT in endodontics should be limited to the assessment and treatment of complex conditions”. The article then lists nine of these “complex conditions”. In summarization, the position paper recognises the value of CBCT as...
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This article showed the following:

- influence of CBCT in the field of orthodontic programmes in the US and Canada was evaluated.

- Many professional organisations in dentistry for general dentists and specialists have acknowledged, at least four as specialties; four (oral and maxillofacial radiology, and orthodontics) and periodontics, oral and maxillofacial dentistry.

- CBCT technology to dentistry. The vast majority of post-doctoral residents in dental implant patient care. Additional under CBCT are the importance of its value in treatment planning and diagnosis. At time progresses, insurance companies may, as they have in the past, require CBCT owner/operators to obtain certification with the IAC or some other regulating entity for an operator/owner to qualify for financial reimbursement from any third party payer.

- Two of the major malpractice carriers of the insurance industry (OMNSC and MedPros) have influenced the evolution of CBCT as a new standard of care by offering coverage for CBCT owner/operators commensurate with the level of risk to which the operator/owner are exposed. Were CBCT studies believed to be of little value or represent minimal risk to the patient, there would be little or no influence from other dentists who utilise the technology, which in turn will influence what the public perceives as a standard of care.

- The value CBCT has in diagnosis and treatment of patients is widespread and recognised by medical disciplines such as plastic and reconstructive surgery, ENT, Craniofacial/CPI surgeons, and OMFS trauma surgeons. These medical disciplines recognise the high quality three-dimensional CBCT provides and assists doctors in the treatment planning and diagnosis of their patients. Such widespread and multidisciplinary application of CBCT imaging contributes to CBCT becoming a new standard of care.

- The insurance industry

- Reimbursement from major insurance carriers for CBCT and thus acknowledged by other disciplines as a new standard of care.

- There are many questions yet to be answered definitively:

1. Who is responsible (and liable) for interpreting the images?

2. Is an entire field of view interpreted or simply the pertinent structures?

3. Must all images be interpreted by a board certified oral and maxillofacial radiologist or can the ordering doctor interpret them?

4. What level of training is sufficient to own and operate the machine, as well as, and interpret CBCT images?

5. What cases deserve a CBCT?

6. If the patient refuses a CBCT and the dentist believes a CBCT is necessary for successful treatment, can the dentist complete the case without fear of legal repercussions?

Lastly, as mentioned earlier, standard of care is an evolving concept. Darwin stated clearly any organism (or concept in this case) which is subject to the laws of evolution must adapt in response to outside forces in order to survive. The standard of care in dentistry is adapting to CBCT as forces (legal, financial, clinical, and consumer) act upon the industry to account for the powerful influence CBCT has on treatment planning and diagnosis. In conclusion, Dr. Whitesides stated that all that glitters is not gold, CBCT may soon represent a new normal for treatment planning and availability will most likely not be determined by the visible hand of the market as the Keynesians laws of supply and demand move the dental industry to provide the best possible service at a price patients and insurance companies are willing to pay. The third (legal) will be slowly determined in the court systems as attorneys will begin to rely more on CBCT in support of their clients’ cases.

Patient expectations are difficult to accurately ascertain. We know patients expect our practices to be contemporary. Buying the latest and greatest machine for your practice may not be wise if cost exceeds benefits both clinically and financially. As CBCT becomes widely accepted and expected by our patients, it will influence your kitting or clinical relevance, incorporating the technology into one’s practice may not be entirely necessary but prudent as others in the profession who possess the equipment are living in the contemporary and advanced in their patient care.

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“Photo-functionalisation is effective on any implant surface type”

An interview with Dr Takahiro Ogawa, US

A professor in the Division of Advanced Prosthodontics at the University of California, Los Angeles School of Dentistry in the US, Dr Takahiro Ogawa is one of the main advocates worldwide for photo-energy-mediated activation of implant materials, a process also known as photo-functionalisation. Dental Tribune Asia Pacific recently had the opportunity to talk with him about the benefits and prospects of this innovation.

Dental Tribune Asia Pacific: Photo-functionalisation is achieved by exposing titanium surfaces to ultraviolet light. Would you describe in more detail and the mechanical or chemical processes that take place during the process?

Dr Takahiro Ogawa: Photo-functionalisation is a 12-minute conditioning of dental implants in the device immediately prior to implant placement. The reason for this process is that titanium ages with time, and this particularly affects its ability to integrate with bone.

The photo-energy activation device boasts an optimised combination of ultraviolet lights that effectively remove hydrocarbon from the implant surface, transforming the surface from hydrophobic (water-repelling) to hydrophilic (water-friendly). This change in properties, together with the clean titanium surface, attracts more osteogenic cells. Photo-functionalised titanium surfaces are electrostatically positive and further enhance cell attraction because cells are electro-negative. All this is intended to make osseointegration of dental implants much better and faster.

The ageing process of implants degrades hydrophilicity. Can the features of an aged implant surface be fully restored by photo-functionalisation, and does the technology have any limits?

Not at all. A series of studies have indicated that photo-functionalisation is effective on any implant surface type tested whether acid-etched, dual acid-etched, oxidised, sand-blasted, nano-featured or machined surfaces.

While photo-functionalisation can restore implant properties to a degree similar to when it was manufactured, the revitalised implant surfaces degrade time-dependently in the same way as those of regular implants. Therefore, dental implants undergoing treatment with the device need to be placed immediately.

Has the technique been tested in in vivo studies and, if so, what results have you found so far?

According to a number of preclinical studies, the strength of osseointegration can be increased three times by photo-functionalisation at the early healing stage. Photo-functionalisation makes implant and abutment surfaces bacteria phobic.

The bone-implant contact of photo-functionalised implants reached 98.2 per cent, compared with 50–55 per cent achieved with the control implants. Moreover, it has been found that photo-functionalisation increases the quality of marginal bone formation, as well as improves the outcome of guided bone regeneration, when applied to titanium mesh. Studies indicate that there are not only short-term benefits of photo-functionalisation. Reliability and predictability in function and aesthetics are expected to increase with time, providing clinicians with a new strategy for a better long-term prognosis for dental implants and reducing the risk of peri-implantitis.

You say that photo-functionalisation could become a standard procedure for dental implant therapy. When will that happen, in your opinion?

Dentists in Japan have been using photo-functionalisation for approximately three years. In Europe, premarketing of the photo-functionalisation device has recently started. I believe that other regions will catch up shortly and make this technology a global standard in implant dentistry. A number of projects are also underway utilising photo-functionalisation in the field of general bone engineering and orthopaedic implants and reconstruction.

Thank you very much for the interview.
Nowadays, most people will associate forensic dentistry primarily with identification and bite mark analysis. These areas do indeed form the majority of an odontologist’s workload. There are, however, other aspects of the discipline that are just as important but perhaps less well known. These include cranio-facial trauma analysis, age estimation for both living and deceased individuals, dental manifestations of child abuse, dental malpractice investigations, as well as dental insurance fraud.

Forensic odontology is an integral part of the medico-legal process. With this comes a responsibility borne by forensic odontology practitioners for the requisite education, qualifications and ongoing training. Courts and legal institutions now require that we have evidence-based research upon which we can rest our findings and conclusions. In addition to knowledge of the law, we have to have knowledge of human anatomy and its relationship to injury patterns and interpretation. Knowledge of bite patterns due to assault, trauma and sexual abuse, as well as child abuse injury manifestations, is also required, as is knowledge of assessment techniques used when the age of an individual is unknown. Finally, there is a need to have knowledge of cranio-facial analysis, identification procedures and methods, principles and practices used when the age of an individual is unknown. Finally, there is a need to have knowledge of human identification and the need to have knowledge of human identification and the need to have evidence-based research upon which we can rest our findings and conclusions.

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The majority of the forensic odontology caseload concerns the identification of unknown deceased individuals, most discussion in this article will concentrate on this.

Honouring the dead is a fundamental precept in all societies. The extent of this communal attention to the deceased varies across the world, but in essence every person hopes that his or her remains will be treated with respect after death. This respect for the dead includes, for many societies, robust identification of the deceased so that relatives and friends are able to treat the remains with appropriate ceremony and are able to visit the resting place of the deceased whenever they wish. So important is the perception of personal identification in almost all societies that authorities will go to extraordinary lengths to ensure that deceased individuals are not interred in unmarked graves, or cremated without a name. In fact, the importance of identification of the deceased is enshrined in the Victorian Coroner’s Act 2008 (section 67), which states “A coroner investigating a death must find, if possible, the identity of the deceased, the cause of death, and the circumstances in which in death occurred.”

Hali Hallenstein, the Victorian State Coroner from 1986 to 1994, also had firm views concerning the importance of human identification, articulated in the following quotation: “It is a hallmark of our civilisation that we regard it as an affront, an indignity, an abrogation of our responsibilities, that a person could live amongst us, die and be buried without a name.” In fact, the importance of identification of the deceased is enshrined in the Victorian Coroner’s Act 2008 (section 67), which states “A coroner investigating a death must find, if possible, the identity of the deceased, the cause of death, and the circumstances in which in death occurred.”

If the same is found in the deceased, positively confirm identity? Definitely not, as many people share this restoration pattern. If, however, we also have antemortem radiographs of those restorations displaying the exact shape, size and location within each tooth, and these compare favourably with the postmortem radiographs, then few would argue that a positive match cannot be confirmed. There is, however, still no way to quantify this match, to put a probability ratio or a percentage certainty to it.

It may be necessary in some cases to compare all of the teeth in a mouth in order to arrive at a match. In other cases, a single tooth with an unusual or complex restoration may be sufficient. It has long been the wish of identification experts to be able to quantify such matches, but no reliable method has yet
been devised and so a degree of expert subjectivity is still required.

Prior to the availability of scientific methods applicable to the issue of positive human identification, the only real option for relatives and friends to recover the mortal remains of their loved ones was to visualize them, and to deduce, regardless of whether the person before them was indeed who they believed him or her to be. On the face of it, positive human identification by visual recognition would seem to be a fairly simple matter, as long as the deceased had undamaged facial features. We can all recognize people who are well known to us by their facial features and mannerisms, even in poor light and at odd angles. This has been shown to be true in many studies concerning the recognition of living people via CCTV security footage. Why then are there documented cases of misidentification through visual recognition of the deceased, even of intact living people via CCTV security footage?

The process of visual recognition is complex and until quite recently not well understood. Clues as to the identity of an individual, either living or deceased, result from a host of factors influencing the physical structure of the face, but also with the variety of facial expressions, the individual’s unique mannerisms, and the context in which the individual is seen.

When good quality ante-mortem dental records are incomplete or many years old or there are no radiographs. For example, ante-mortem images with which contemporaneous dental images (Fig. 1) can be compared using a simple radiographic overlay. The absence of restorations and the effect on anatomical landmarks may also be employed. Root and pulp chamber morphology are useful for age estimation work has concentrated on the ageing of children up to 15 years. Beyond this age, dental morphology, sinus configuration, the biomechanics of bone, and the effect on anatomical structures of various degrees of force.

Age estimation has always been a function of the forensic odontologist, and traditionally has been based on an analysis of dental development and comparison with published standards for different age groups (Figs. 1). The majority of age estimation work has concentrated on the ageing of children up to 15 years. Beyond this age, dental morphology, sinus configuration, root and pulp chamber morphology are useful for age estimation.
able in its development. It has been recognized recently, however, that published standards for tooth development may not be as accurate as assumed, owing to the fact that they were constructed many decades ago and in other parts of the world, and therefore may bear little resemblance to modern populations. Considerable work is currently underway to address this issue, with new population datasets being established around the world.

Odontologists are also re-searching the ability to estimate more accurately the age of older individuals, around the adult/child demarcation age of 18 years. This is being achieved through the use of multifactorial approaches, where the third molar and various other skeletal development sites are assessed together in order to arrive at an estimate (Figs. 5a–c). This is seen as important research in light of the increasing need to determine the legal status of individuals such as asylum seekers, accused human traffickers who may be children and not being incarcerated in an adult prison, child soldiers, and victims of sexual assault in developing countries, all of whom are unlikely to possess proof of age documentation.

It has been shown that more than half of all cases of child abuse involve cranio-facial injuries, perhaps owing in part to the significance of the face and mouth in communication and nutrition. Forensic odontologists are rarely involved in these difficult cases, but despite this play an important role in injury description and providing help with determination of causation. All of the principles involved in cranio-facial trauma analysis for adults are applicable here, but with emphasis on the developing anatomy and different biomechanical characteristics of the child facial skeleton.

Dental malpractice and insurance fraud investigations are increasing, partly owing to greater public awareness of what constitutes a dentist’s duty of care and responsibility to patients, and partly owing to our increasingly litigious society. For this aspect of practice, the odontologist requires thorough knowledge of the various pieces of legislation relating to dental practice, the professional codes of conduct, and the latest information on treatment modalities, as well as good medicolegal report writing skills.

Conclusion

Forensic odontology is capable of providing rapid and relatively cost-effective identification of the deceased, as long as reasonable ante-mortem dental records are available. In countries such as Australia, the laws concerning medical record-keeping ensure that dental records are, in the main, of good quality and easily retrieved in the event they are required.

In other countries, this may not be the case, and identification...
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