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functional requirements of the patient. The situation achieved with this rather gradual approach was used as a reference in the subsequent fabrication of the final restoration (Fig. 1).

It was then time to select the materials and manufacturing method that would allow the data gathered in the previous processes to be converted into a high-strength aesthetic restoration. We opted for the IPS e.max CAD-on technique/IPES e.max CAD Veneering Solutions, as this method allowed for accurate reproduction of the diagnostic wax-up. Dedicated software divides the data into two sets for the production of the ZrO2 framework and the LS2 veneering structure. The model and the wax-up were both digitalised and imported into the program (Figs. 6a & b).

The primary structure (framework) was created using ZrO2 according to the CAD/CAM technique. Its accuracy of fit was checked on the model and then the framework was sent to the practice for try-in (Figs. 7–9). The framework showed an excellent fit and did not require any reworking (Fig. 10). Based on the data, the veneers were milled from IPS e.max CAD. This secondary structure was easy to adapt to the framework (Fig. 11). Still in their intermediate (pre-crystalline) state, the LS2 veneers were adjusted to match the pre-existing morphological characteristics. A base for veneering the gingival parts was also created. Contouring the artificial gingiva with composite material by a dentist would happen at a later stage.

We were now ready for the final stage. After checking the functional and morphological parameters, we joined the ZrO2 framework and LS2 veneer with the IPS e.max CAD Crystal/Connect fusion glass-ceramic and an Inovox mixing device (Figs. 12a & b). Crystallisation or fusion firing was conducted in a Programat furnace using a dedicated firing program. Afterwards, the restoration was customised to match the specific characteristics of the patient’s dentition and subjected to a characterisation/glaze firing process (Figs. 13 & 14).

Completing the restoration
After the try-in, the restoration was returned to the laboratory to add some final touches. A few characterisations were applied according to the given requirements. Those areas of the framework to be veneered with composite were etched to prepare them for the application of the composite material. In the practice, the gingival parts were reproduced using gingiva-coloured composite with the temporary as a guide (Fig. 15). A natural-looking gingiva shield was achieved by applying the material in small quantities in several steps. Finally, the all-ceramic bridge was seated using conventional procedures. The result was a restoration that blended in so well that it could hardly be distinguished from the surrounding natural dentition (Figs. 16 & 17).

Chipping of the veneering ceramic on ZrO2 frameworks can often be traced back to a failure to observe the material-specific technical requirements. By using the CAD-on technique described in this report, the risk of failure can be minimised for these kinds of restorations, because the strength of the veneering ceramic used with this technique is four to five times higher than that of conventional veneering ceramics.

The high strength of the ceramic has been confirmed in a study that compared bridges manufactured using the CAD-on technique with ZrO2 bridges veneered using an individual layering technique. The results of the study showed that the strength of the CAD-on bridges was twice as high (2,188 ± 305 N) as the strength of conventionally veneered bridges.

In this case, accurate diagnostic measurements taken at the preservative 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 Vigani and Dr Leonardo Barchirolin from Florence. I would like to thank them both for their support.

Reference

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Brisbane Convention and Exhibition Centre - an AEG EARTH venue
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On behalf of the Local Organising Committee of the 36th Australian Dental Congress, it is with great pleasure that I invite you to attend Congress and enjoy the river city of Brisbane.

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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 dental procedures, orthodontic, endodontic, or endodontic cases.

The advancement of CBCT in dentistry has caught the attention of manufacturers of radiographic 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 50 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 free, thereby reducing his overall cost of operation.

Standard of care is a legal and not a medical or dental concept. Standard of care is continually evolving as methods and techniques in patient care improve. An appropriate definition for the technology, like CBCT, into a new standard of care involves many criteria. These criteria include but are not limited to: court verdicts, expert testimony, literature support, professional guidelines, cost and availability of the technology, reimbursement by third party payers, and multi-specialty use and recognition.

Taken individually, these criteria do not constitute a mandate for any technology as a standard of care. Nor are these the only criteria one may use in determining standard of care. Taken together, these criteria provide strong evidence that CBCT technology has sufficiently evolved to be considered the standard of care in maxillofacial imaging in selected cases to assist the dentist in treatment for patients in need of dental implants, orthodontic surgery, management of difficult impacted teeth, endodontics, endodontics, and many other facets of dentistry.

The legal perspective
The legal system in the United States is complex and fragmented. No database exists to search verdicts in dental malpractice cases in which CBCT has played an important or pivotal role. For a new technology to become admissible as a standard of care in court, it must pass the Frye test. This standard comes from Frye v. United States which is a 1923 in a case discussing the admissibility of a polygraph test as evidence. The Frye standard of the principle must be recognised, and while the courts will go a long way in admitting experimental testimony derived from a well-recognised scientific principle or discovery, the thing from which the deduction is made must be sufficiently established to have gained general acceptance in the particular field in which it belongs.

In many jurisdictions and in Federal court, the Frye standard is superseded by the Daubert standard. The Daubert standard is used by a trial judge to make a preliminary assessment of whether an expert’s scientific testimony is based on reasoning or methodology that is scientifically valid and can properly be applied to the facts at issue. Under this standard, the factors that may be considered in determining whether the methodology is valid are:

- theory or technique in question can be and has been tested;
- it has been subjected to peer review and publication;
- there is a known or potential error rate;
- the existence of maintenance standards controlling its operation;
- widespread acceptance within a relevant scientific community.

The theory or technique behind medical grade computed tomography and CBCT has been tested and proven sound over many years of application in the medical and dental arena. The Hupeed unit is the widely recognised standard quantitative scale 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 states (Iowa, South Dakota, and New Hampshire) an expert need only request liability 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 the last five 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 for medicine. In fact, in the years preceding WWI, 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 councils 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 in post-treatment rendering of an opinion. When reviewing a case, CBCT can be seen as an additional and important piece of information to help explain why the doctor did what he did or why an unfortunately 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.

Literature Support
For any technology to be considered as a standard of care, a plethora of literature in support for the technology should exist. The literature must discuss the risk and benefits of the technology, its impact on patient care, and guidelines and protocols for acceptable use.

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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, cone beam CT + dental implants, cone beam CT + orthodontics, cone beam CT + oral surgery, cone beam CT + endodontics 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.

### Key words in search | Number of articles | Year article first appeared
--- | --- | ---
CBCT | 5,537 | 1988
CBCT + dental | 1,951 | 1998
CBCT + dental implant | 617 | 2002
CBCT + orthodontics | 721 | 2003
CBCT + oral surgery | 1,061 | 1998
CBCT + endodontics | 511 | 2007

### Table 1

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

### 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 and professionals that 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 courses 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 USA. 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 (AEE) 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 summarisation, the position paper recognises the value of CBCT as...
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**Cost and availability**

The cost of CBCT machines today range from US$150,000 to US$250,000 with yearly maintenance. This price is for the US$8,000 to US$20,000 range. As with any emerging technology, advances in the field, capabilities of the newest machines demonstrate themselves, the slightly non-conventional machine will represent a significant advancement for the dentist versus the dentist that is not offering CBCT or the one offering CBCT may provide dose savings an adjunct to 2-D images and planning of patients, insurance companies, or patients. In addition, the increased awareness that CBCT is a standard of care, and that all that glitters is not gold, many professional organisations in dentistry for general dentists and specialists have been formally declare CBCT is a standard of care. Dentists and specialists have been required to own, operate, and interpret CBCT, which comprise dentistry may not formally declare CBCT is a standard of care for every patient, and CBCT is the new standard of care. CBCT machines are becoming ubiquitous as more dentists and specialists acquire CBCT, CBCT education and training and recognition are necessary or simply provide a new standard of care.

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1. **Who is responsible (and liable) for interpreting the images?**
2. Is an entire field of view interpretation necessary 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 the images?**
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?**

Lastly, as mentioned earlier, standard of care is an evolving concept. Darwin stated clearly that all that glitters is not gold, many professional organisations in dentistry for general dentists and specialists have been required to own, operate, and interpret CBCT, which comprise dentistry may not formally declare CBCT is a standard of care for every patient, and CBCT is the new standard of care. CBCT machines are becoming ubiquitous as more dentists and specialists acquire CBCT, CBCT education and training and recognition are necessary or simply provide a new standard of 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.

Dr Takahiro Ogawa: Photo-functionalisation makes implant and abutment surfaces bacteria phobic.

The bone-implant contact of photofunctionalised 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.

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.

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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.
Forensic odontology—Broader than just identification

Dr Richard Bassed
Australia

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 medical-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 mark 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 human identification methods, principles and practices, as well as mass disaster identification procedures and protocols, and the ethical issues involved in the examination and management of dead bodies, and to have an understanding of human rights issues involved in war crimes investigations.

All of these require thorough knowledge of cranio-facial anatomy, dental anatomy, dental and skeletal development, injury interpretation and medical-legal report writing. It is also important to have a good understanding of the law relating to the practice of dentistry, the coronial system, and the criminal justice system. As 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.

To be buried anonymously goes against all of our religious, cultural and ethical belief systems, and implies that a life unremembered and unmourned was really a life without consequence. William Gladstone, Prime Minister of Britain in the mid-1800s, encapsulated this sentiment better than most when he said, “Show me the manner in which a nation cares for its dead and I will measure with mathematical exactness the tender mercies of its people, their loyalty to high ideals, and their regard for the laws of the land.”

Positive identification of the deceased not only satisfies a commitment to probity, but also resolves many legal issues surrounding an individual’s death, such as inheritance and life insurance. If a deceased person remains unidentified, then technically he or she will not be declared dead for a number of years, thus creating further distress to families who not only are unable to put their lost loved one to rest, but may suffer financially as well.

Personal identification of the deceased, and occasionally the living, is achieved through a variety of scientific and sometimes unscientific methods. Practitioners from forensic science, forensic medicine, law enforcement and coroners’ offices apply their own particular set of skills to an identification problem in order to arrive at an answer. The most separated into two broad categories. The first consists of those methods that are presumptive for identification, such as circumstantial evidence, property associated with the body, and visual recognition. These methods involve a high degree of subjectivity and rely on identifiers that are not intrinsic to the body itself, are dependent on lay interpretation, and therefore can be falsified or mistaken (commonly known as secondary identifiers). The second category relies on scientific analysis of identifiers that are intrinsic to the body, such as dental restorations, fingerprints, DNA, and verifiable medical records (primary identifiers). These involve characteristics that can be objectively appraised and compared to ante-mortem exemplars in both a quantitative and a qualitative way, and that are difficult or impossible to falsify.

Of all the scientific methods, molecular biology is the only method that can mathematically quantify the degree of certainty for a particular match, with the other methods (including odontology) being somewhat dependent on more subjective method-ology and expert opinion. This reliance on even a small level of subjectivity can raise issues in courts when lay people do not have a deep understanding of the methods employed in an expert’s conclusion.

Confusion can arise from the fact that there is often no unanimous indication regarding which and how many character-istics are necessary in order to achieve a positive identification. The recurrence of discordant features excludes identity; the occurrence of several concur-rent features commonly observed among the population does not allow a final judgment on identification, whereas even a few features rarely observed can lead to a positive match. An example of this is a case in which the written dental chart describes amalgam restorations in each first molar.

If the same is found in the deceased, is this sufficient evidence to confirm identity? Definitely not, as many people share this restoration pattern. If, however, we also have ante-mortem radiographs of those restorations displaying the exact shape, size and location within each tooth, and these compare favourably with the post-mortem 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 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 visually examine the body and to reach a decision regarding 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 recognise people who are well known to us by their facial features, scars and mannerisms, even in poor light and at odd angulations. 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 and undamaged faces?

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, rest with the physical and structural features of the face, but also with the variety of facial expressions, their unique variations and mannerisms, and the context in which the individual is seen.

DNA profiles are encrypted sets of numbers that reflect a person’s DNA make-up, which can also be used as the person’s identifier. Although 99.9 per cent of human DNA sequences are the same in every person, enough of the DNA is different to distinguish one individual from another, unless they are monozygotic twins. DNA profiling using identification using fingerprint prints (friction ridges) relies on an examination of the incomplete or damaged remains on file with the authorisation of the dead. The major reason for using DNA fingerprinting in forensic investigation is that it is reliable; there is no room for error, as each DNA fingerprint is unique to the individual, regardless of the individual’s age, race, or gender. DNA fingerprinting can be used to identify individuals who have died, either from natural causes or from trauma. It is also used to identify victims of child abuse, victims of terrorist attacks, and perpetrators of violent crimes.

A deceased person has lost all facial expression, animation, and context and simply looks different from when he or she was alive. Incipient decompositions occur and, with the physical and structural structure of the face, but also with the variety of facial expressions, the unique variations and mannerisms, and the context in which the individual is seen.

Dental identification is closely related to victim identification, as the teeth and maxillofacial skeleton may also be employed. Root morphology may also be employed. The dental identification system is employed under threshold scoring rules, determining whether two friction ridge imprints are likely to have originated from the same finger or palm (or toe or sole). The validity of forensic fingerprint evidence has been challenged by academic, judicial and the media. While fingerprint identification was an improvement on earlier anthropometric systems, the subjective nature of matching (especially when incomplete latent prints are used) is still very difficult to resolve. It has introduced an element of controversy.

Dental record comparison can be used for identification purposes when there is sufficient ante-mortem evidence of unique medical intervention or disease. Examples include the discovery of medical prostheses, such as pacemakers and prosthetic hips, which will have engraved on them serial numbers, which can also be challenging. In order to reach conclusions to these difficult identification puzzles, the forensic dentist not only needs a solid grounding in all of the techniques available, but also requires a level of experience and, in the early years of a degree of mentoring.

Dental identification is not only achieved using comparison of restorations; other features of the teeth and maxillofacial skeleton may also be employed. Root morphology, sinus configuration, unusual crown shape, and pulp chamber morphology are all factors that can be considered in the absence of restorations, as long as there are high-quality ante-mortem images and photographs of the dentition, which are all useful aids for a forensic odontologist and are employed with varying degrees of certainty, depending on the circumstances of the case.

Personal identification via dental record comparison is similar to fingerprint analysis in that it is a thoroughly mechanical process, and an element of subjectivity involved in the matching process. Where dental record identification differs, and is perhaps easier to comprehend for lay people, is in the nature of the comparisons being made. With dental evidence, matches are commonly assessed by comparing ante-mortem and post-mortem radiographs of easily identifiable man-made (and most often hand-made) restorations. Unlike the minute differences between the wheels and axles of fingerprint evidence, dental radiograph comparisons are often so obvious that no reasonable person is able to say that the images belong to the same person.

Fig. 1: In the course of cranio-facial trauma, an incriminating description can be vital in these cases.

Fig. 2: The identification of persons using fingerprints was an early favourite defence technique. While the fingerprint identification process is easily simplified, it is a scientific approach and is thus scientifically reliable, as only the third molars are available for assessment, and this tooth is notoriously vari-

Figs. 3a-c: Multiple development sites used for age estimation of late teenage individuals: in this case, the third molar, the medial clavicular epiphysis, and the sphenoidal-synchondrosis complex, all of which are useful age indicators in the late teenage years.

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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 researching 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 (Fig. 1-4). 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 risk 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

of the deceased in some parts of the world represents a serious and ongoing issue for governments and humanitarian organizations. Good record-keeping is not only of benefit to forensic practitioners, but also relevant to the work of odontologists includes educating health services and outcomes for patients in general, so part of the work of odontologists includes educating health authorities in less developed parts of the world to encourage good record-keeping. The benefit of good record-keeping can be seen in recent mass fatality incidents, such as the Victorian Black Saturday bushfires, where, despite the availability of a well-resourced DNA capability, more than half of all victims were identified by dental record comparison.

The scope of forensic odontology is broader than identification alone and encompasses a variety of forensic fields, including law, pathology, clinical forensic medicine, molecular biology and anthropology. The forensic odontologist encounters all of these disciplines in different case scenarios, and in order to understand how the odontologist can contribute best to an investigation he or she needs to comprehend the capabilities and limitations of these fields.

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In this discipline requires not only a comprehensive understanding of odontology theory and technique, but also a degree of knowledge and experience in a variety of forensic fields, including law, pathology, clinical forensic medicine, molecular biology and anthropology. The forensic odontologist encounters all of these disciplines in different case scenarios, and in order to understand how the odontologist can contribute best to an investigation he or she needs to comprehend the capabilities and limitations of these fields.
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