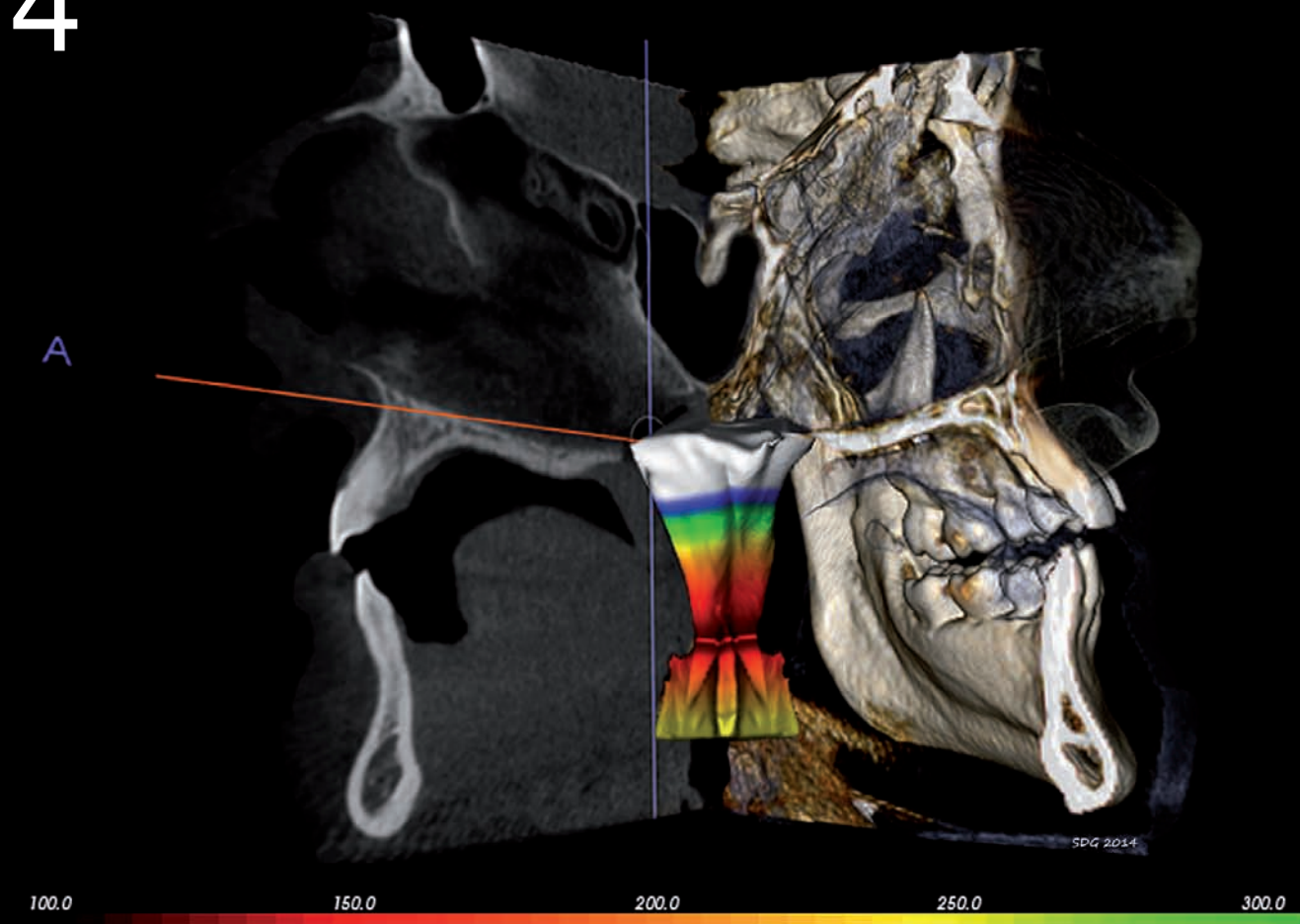


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4²⁰¹⁴



| opinion

CBCT: Is dentistry ready for a new standard of care?

| case report

CBCT in assessment of the anatomic relations

| meetings

EOO 2014—Simplifying dental implant treatment

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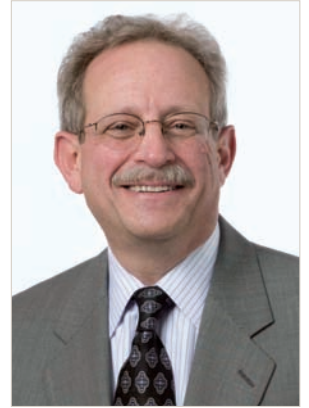
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CBCT, smart bands and airway analysis

It is that time of the year again: everyone is getting ready to close out 2014 and usher in the new year. It is always informative to review the events of the past year and to speculate on what the future will bring. The march of high technology continues with the various gadgets that appear just in time for holiday gifts. The more high-tech, the more desirable and sought after, and it appears that nothing is safe from the incorporation of digital data in some form.



Dr Scott D. Ganz

While not entirely new, the concept of wearable technology has blossomed into a multibillion-dollar industry during the past few years. In fact, there is an upcoming Wearable Tech Expo in New York on 2–4 June 2015. Dr Shawn DuBravac, Chief Economist and Senior Director of Research for the Consumer Electronics Association, has stated that we need to harness wearable data because "the union of wearable technology and health care has the potential to address the trifecta of issues burdening the US health care system: rising costs, lack of coordination in providing care, and the increase in chronic diseases tied to lifestyle". We now have digital smart bands and watches, like the soon-to-be-released Apple Watch and the Samsung Gear S, which can not only tell time, but also monitor your heart rate, count your steps, tell you how many floors you have climbed, and detect changes in elevation when linked to your smartphone—all in the name of keeping us physically fit.

One area that is relevant to readers of **cone beam international magazine of cone beam dentistry** is the ability of smart bands to measure sleep patterns. Gadgets like Sony's SmartBand, Microsoft Band and Jawbone's UP3 are selling worldwide, and some claim to be capable of distinguishing between REM, light and deep sleep. Chris Haslam of Wareable (www.wareable.com) states that "virtually every fitness tracker has the ability to map your shut-eye. They work by continuously monitoring your movements during sleep—known in professional sleep circles as Actigraphy—and assessing sleep-wake cycles to see whether you're in deep or light sleep." These devices also show you a graph of your sleep patterns on an application on your smartphone. There are even trackers that can use your phone's microphone to record sleep noises, like snoring, to explain why you may wake up several times each night. He states that "while not as accurate as professional sleep monitoring equipment, or lab tests, fitness bands can help paint a clearer picture of your own sleep cycles."

Within the dentist's scope of care is the potential to diagnose and treat patients who exhibit sleep problems and specifically sleep apnoea in its various forms. CBCT data as interpreted through sophisticated software applications may be our digital link to accurate diagnosis and treatment of these sleep disorders. Airway analysis has become a hot topic at CBCT-related symposia—which prompted the composite artwork for this issue's cover. In a recent article, Alsufyani et al. conducted a systematic review of the use of CBCT to assess upper airway changes and treatment outcomes of obstructive sleep apnoea.¹ The article concluded that "the available published studies show evidence of CBCT measured anatomic airway changes with surgery and dental appliance treatment for OSA. There is insufficient literature pertaining to the use of CBCT to assess treatment outcomes to reach a conclusion. High-quality evidence level studies, with statistically appropriate sample sizes and cross validated clinically, are needed to determine if CBCT airway dimensional changes are suitable for assessment of treatment outcome." More study is needed, of course, but clearly evidence is mounting that CBCT will play a vital role in the assessment and treatment of sleep disorders.

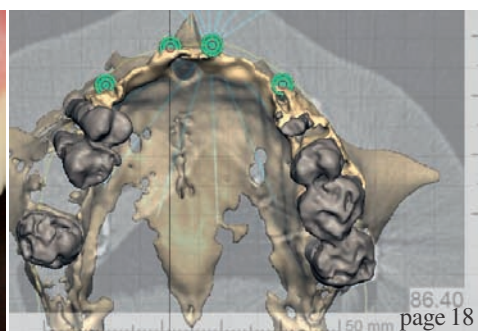
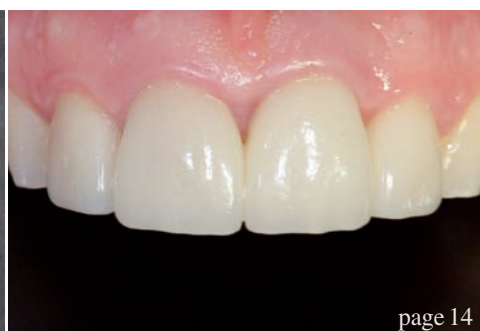
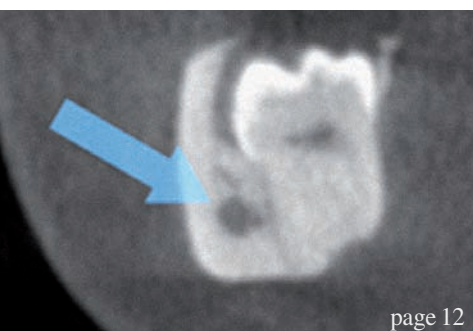
Perhaps we will soon be linking the digital data from wearable tech-savvy smart bands provided to our patients as we monitor the airway space with our CBCT data. Just another amazing link between the incredible data afforded to us through our CBCT devices and another potential means to help our patients. Continue to witness our digital evolution that will affect our lives in 2015 and beyond by following the many informative articles contained within the covers of the latest issue of **cone beam international magazine of cone beam dentistry**.

Respectfully,

Dr Scott D. Ganz, Editor-in-Chief

Reference:

¹ Alsufyani, N.A., Al-Saleh, M.A.Q. & Major P.W., "CBCT assessment of upper airway changes and treatment outcomes of obstructive sleep apnoea: A systematic review", *Sleep and Breathing*, 17/3 (2013), 911–23.



editorial

- 03 **CBCT, smart bands** and airway analysis

| Dr Scott D. Ganz

opinion

- 06 **Cone Beam** Computed Tomography:
Is dentistry ready for **a new standard of care?**

| Dr Lee M. Whitesides

case report

- 12 **CBCT in assessment** of the anatomic relations
of a **deeply impacted lower third molar**
to important anatomical structures

| Prof. Snježana Čolić, Dr Jelena Stepić

- 14 **Challenging multi-disciplinary approach**
to a damaged tooth in the maxilla

| Dr Michael R. Norton

- 16 **Papillon-Lefèvre syndrome**
treatment with partial bone graft technique

| Dr Izdihar Alchab

- 18 **Paving the way for a patient-friendly, minimally**
invasive approach in alveolar ridge augmentation

| Dr Yasmin Buchaekert

industry report

- 22 **CBCT and CAD/CAM** allow for
one-day restoration of tooth 21

| Dr Robert Pauley

industry news

- 26 **Planmed Verity**—a mobile 3-D **unit without parallel**

| Planmeca

- 28 **3Shape Implant Studio**
receives FDA market clearance

| 3Shape

special

- 30 **Daktari for Maasai**—
Mobile Dental Care in the Serengeti

| Prof. Martin Jörgens

meetings

- 38 **Simplifying dental implant treatment**

| EAO

- 40 **International Events**

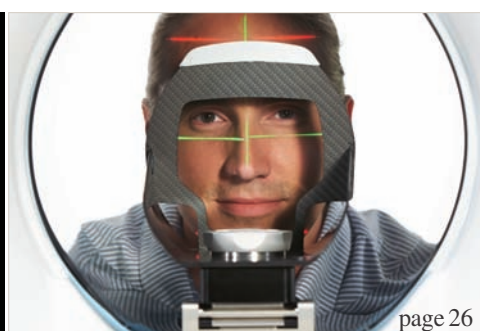
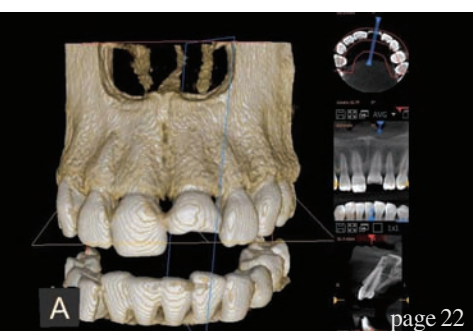
about the publisher

- 41 | submission guidelines

- 42 | imprint



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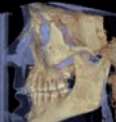
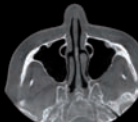
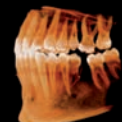
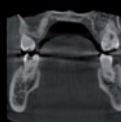
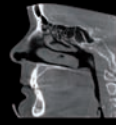
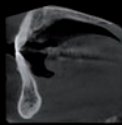
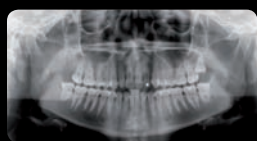
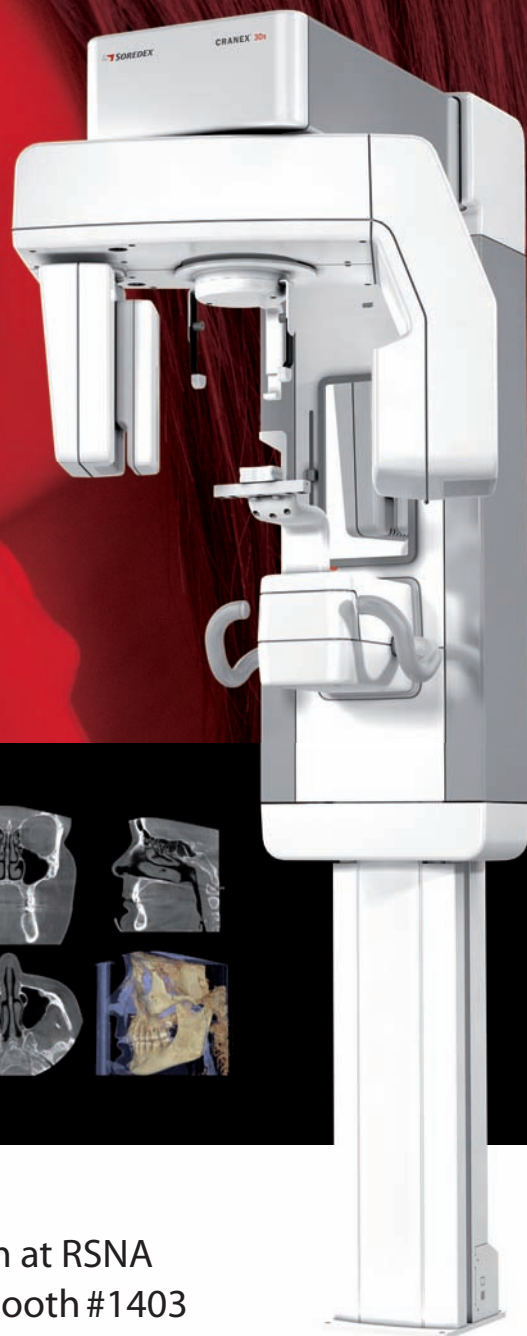
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Cone Beam Computed Tomography: Is dentistry ready for a new standard of care?

Author _ 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 dental implant, orthognathic, orthodontic, or endodontic cases.

The advancement of CBCT in dentistry has caught the attention of manufacturers of radiological 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 % of their digital imaging sales to almost 50 % 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 his overall cost of operation.

Standard of care is a legal not a medical or dental concept. Standards of care 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 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, orthognathic surgery, manipulation of difficult impacted teeth, orthodontics, 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 Frey test. This standard comes from *Frey v. United States* which is a 1923 in a case discussing the admissibility of a polygraph test as evidence. The Frey standard 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 principle must be recognised, and while the courts will go a long way in admitting experimental testimony deduced 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 Frey standard is superseded by the Daubet standard. The Daubet 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 Hounsfield unit is the widely recognised standard quantitative scale for describing radiodensity 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 Daubet 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 Daubet 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 as the standard of care for every case in 2014.

Expert Testimony

An expert is a person with sufficient minimal 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 in a related field 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 correspondences. In the last five years, the author has noticed a remarkable increase in the number of cases in which plaintiffs and defence 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 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.

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	725	2003
CBCT + oral surgery	1,041	1998
CBCT + endodontics	313	2007

Table 1

Logic would dictate that if plaintiffs and defence counsels 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 the jury) 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 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 each and 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 application to patient care, and guidelines and protocols for acceptable use.

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. 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 in 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 in dentistry who 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 % 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 % 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 % 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 summation, the position paper recognises the value of CBCT as an adjunct to 2-D images and "CBCT may provide dose savings over multiple traditional images in complex cases".

Literature pertaining to the use of CBCT in endodontics first appeared in the *Journal of Endodontics* in 2003. The American Association of Endodontists sponsor continuing education in endodontic related CBCT on their website and the organisation devotes valuable time at its annual meeting to CBCT as it relates to modern endodontics. Most residencies (44 of 47) in endodontics provide CBCT for patient care.

Literature pertaining to CBCT in dentistry dates back to 1998. The AAMOR devotes considerable effort to continuing education relating to CBCT both on its website, through CE events, and at its annual meeting. All seven ADA approved residencies in Radiology incorporate CBCT education and training into the resident curriculum.

The tremendous value of anatomic truth in complex orthodontic cases involving patients with

cleft lip and palate, impacted teeth, and maxillofacial deformities is widely recognised and discussed in the literature. Review of the AAO annual meeting lecture syllabus shows CBCT is a prominent topic for today's orthodontist. In a recent article in the *Journal of Dental Education* by Smith et al use of CBCT in orthodontic programmes in the US and Canada was evaluated. This article showed the following:

- _ 83 % of orthodontic programmes have access to CBCT,
- _ 73 % of programmes report "regular" use of CBCT in patient diagnosis,
- _ Areas of CBCT use focuses on diagnosis and treatment planning for: impacted teeth, craniofacial anomalies, TAD placement, TMJ assessment, upper airway analysis, and maxillofacial development.

Literature discussing CBCT in periodontics first appeared in the AAP journal over a decade ago. The American Association of Periodontist annual meeting agenda and the *Journal of Periodontology* demonstrate a heavy influence of CBCT in the field of periodontics. All 51 post-doctoral US periodontal programmes use CBCT in patient care.

The International Congress of Oral Implantologists (ICOI), the world's largest dental implant organisation and provider of dental implant continuing education with an excess of 25,000 active members, published a consensus report on CBCT in its journal *Implant Dentistry* in April of 2012. In the article, authored by many leaders in the dental implant field, the ICOI states: "The literature supports the use of CBCT in dental implant treatment planning particularly in regards to linear measurements, 3-D evaluation of alveolar ridge topography, proximity to vital anatomic structures, and fabrication of surgical guides." The ICOI reminds the dentist that use of CBCT must be justified in each case and should be considered as an imaging alternative where conventional radiographs may not provide sufficient anatomic truth. Literature discussing the application of CBCT in implant dentistry is ubiquitous and comprises the lion's share of research in applying CBCT technology to dentistry. The vast majority of post-doctoral residencies involved in dental implant patient care and all private dental implant training courses in the US incorporate CBCT in their dental implant education curriculum.

Many professional organisations in dentistry for general dentists and specialists have weighed in on CBCT by providing recommendations, guidelines, and a position paper. While these guidelines are beneficial in establishing a society or specialty's position on CBCT, they are not mandates. Recommendations, guidelines, CE programmes, and posi-