Cone Beam Computed Tomography

Is dentistry ready for a new standard of care?

By 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, CBCT technology has sufficiently evolved to be considered the standard of care. The legal system in the United States is complex and fragmented. The influence of an emerging technology as a standard of care. CBCT by the medical and dental community is demonstrated by the ever increasing presence in dental and medical practices of the technology. Additionally, The Inter-societal Accreditation Commision, an accreditation organisation for medical and dental imaging, has developed guidelines and accreditation criteria for 3-D CBCT imaging. CBCT technology has evolved to be considered the standard of care in court, it must be sufficiently established and accepted.

The theory or technique behind medical grade computed tomography and CBCT has been tested and proven over many years of application in the medical and dental arena. The Housefield unit is the only recognized 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 has advanced from exceptional imaging sales in the last five years. The Frey standard is superseded by the Daubert of application in the medical and dental community.

The legal perspective

The legal system in the United States is complex and fragmented. The theory or technique behind medical grade computed tomography and CBCT has been tested and proven over many years of application in the medical and dental arena. The Housefield unit is the only recognized 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 Inter-societal Accreditation Commission, an accreditation organisation for medical and dental imaging, has developed guidelines and accreditation criteria for 3-D CBCT imaging. CBCT technology has evolved to be considered the standard of care in court, it must be sufficiently established and accepted.

No database exists to search vericts 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 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:

- the 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.

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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-specialist use and recognition.

Today’s patients expect their dentist and physician to be contemporary with technology and science. 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.

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When reviewing a case for suspected malpractice the expert must distinguish between standard of care and negligence. The opinion of one practitioner is not an expert opinion of all practitioners. It is an opinion based on fact, experience, and knowledge which the expert believes to be relevant, valid, and upheld in the scientific community.
The DTI publishing group is composed of the world's leading dental trade publishers that reach more than 650,000 dentists in more than 90 countries.
Professional correspondences. In the last five years, the author has noticed a remarkable increase in the number of cases in which plain- tiffs and defense attorneys, as well as experts, rely on pre- and post-procedure CBCT imaging studies in order to prove malpractice or defending good practice. Post-treatment radiographic imaging to prove malpractice or support good practice is not new to medicine. In the last 50 years precedent and 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 counsels and ex- perts are making CBCT part of their strategy, then CBCT must be not only prevalent and pertinent but of importance in the value 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 laypersons/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 be- fore the procedure is determined by the dentist based on his experi- ence and knowledge of the case.

**Literature Support**

For any technology to be con- sidered 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 ap- plication to patient care, and guide- lines 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 + den- tal, cone beam CT + dental im- plants, cone beam CT + orthodontics, cone beam CT + oral surgery, cone beam CT + endodontics in the search line. The results are listed in Table 1.

<table>
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<th>Key words in search</th>
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<td>CBCT + endodontics</td>
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| Literature pertaining to the use of CBCT in endodontics first appeared in the Journal of Endo-odontics in 2003. The American Association of Endodontists (AAO) has released an official position paper on CBCT. This paper makes many important points, such as limitations to the use of CBCT for diagnostic purposes, radiation exposure and in- crease resolution, careful patient selection in CBCT, and the responsi- bility of the clinician to interpret the entire image. The position paper goes on to declare “the use of CBCT in endodontics must be limited to the assessment and treatment of complex conditions.” The article then lists a number of these “complex conditions.” In summation, the position paper recognises the value of CBCT as an adjunct to 2D images and “CBCT may provide dose savings over multiple tradi- tional images in complex cases.”

The International Congress of Oral Implantologists (ICOI), the world’s largest dental implant or- ganisation 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 sup- ports the use of CBCT in dental im- plant treatment planning particu- larly in regards to linear measure- ments, 3D evaluation of alveolar ridge topography, proximity to vital anatomic structures, and fab- rication 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 con- ventional radiographs may not provide sufficient anatomic truth. Literature discussing the appli- cation 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 residency programs that comprise dentistry may acknowledge the value and presence of CBCT by listing CBCT as a standard of care, those in many important points, such as limitations to the use of CBCT for diagnostic purposes, radiation exposure and in- crease resolution, careful patient selection in CBCT, and the responsi- bility of the clinician to interpret the entire image. The position paper goes on to declare “the use of CBCT in endodontics must be limited to the assessment and treatment of complex conditions.” The article then lists a number of these “complex conditions.” In summation, the position paper recognises the value of CBCT as an adjunct to 2D images and “CBCT may provide dose savings over multiple tradi- tional images in complex cases.”

The American Association of Oral and Maxillofacial Surgeons (AAOMS) has over 9,000 members including but not limited to court verdicts, expert testimony, legal guidelines, the cost of the technology, and reimbursement by third party payers, the recommendations, guidelines, and position papers may facilitate the evolution of CBCT into a standard of care. Thus, in 2014 the professional organisa- tions that comprise dentistry may not formally declare CBCT is the standard of care. In but these organisations do recog- nise the influence CBCT is having on the profession.

**Cost and Availability**

The cost of CBCT machines today range from US$50,000 to US$200,000 with yearly main- tenance fees in the US$8,000 to US$25,000 range. As with any emerging technology, advances create a secondary market for slightly used machines. Each new improved technology machine has the CBCT machine of only a few years ago slightly out of date, de- pending on the models and ranges in price. The CBCT machines should not be considered an exception to two dimensional films. As time progresses and advance- ment towards technological advances of the newest machines demon- strate themselves, the slightly non- contemporary machine will repre- sent itself as an asset in comparison with the dentist versus 2D radiography, while not burdening the dentist.
with significant cost. This will undoubtedly lead to an increase in the number of dental professionals utilising CBCT in their practices. The bottom line for most practices in regards to CBCT machines is: can I afford this for my practice?

To determine affordability, the price of the machine (purchasing and maintenance) must be considered against potential revenue generated by the machine. Revenue can be directly from patients, insurance companies, or from other dentists who utilise the CBCT machine. A cost-effective alternative to owning and operating a CBCT device can be the outsourcing of the study to a third party (dentist or facility) and insourcing the software necessary to employ the images in treatment planning and diagnosis.

CBCT machines are becoming ubiquitous as more dentists purchase the machines and more third party non-dentist owned imaging centres enter the market. More dentists and more patients are becoming exposed to the technology. Patient acceptance will increase, facilitating the incorporation of CBCT into the mainstream culture of dentistry. The increasing omnipresence of CBCT technology will not singularly make it standard of care, but it will serve to increase patient awareness of the technology, which in turn will influence what the public perceives as a standard of care.

The insurance industry

Reimbursement from major insurance companies and government-sponsored health care is traditionally the last to embrace (i.e. pay for) a new service such as CBCT. Although codes for medical CBCT have been around for decades, specific codes for in-office CBCTs began to materialise in 2009. Current reimbursement rates for in-office CBCTs average around US$300, provided the study is covered.

By providing dentists with a CPT code, the insurance industry has validated the technology of CBCT and thus acknowledged its value in treatment planning and diagnosis. As time progresses, insurance companies may, as they have in the past, require CBCT owner/operators to obtain a certification via the IAC or some other regulating entity for an owner/operator to qualify for financial reimbursement from any third party payer.

Two of the major malpractice carriers of the insurance industry (OMNISC and MedPro) 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 owner/operators are exposed. Were CBCT studies believed to have little value or represent minimal risk these leaders in the dental malpractice industry would not offer such coverage. Additionally OMNISC requires the owner/operator to have CBCT images interpreted by a dental or medical radiologist to minimise risk.

Two of these aspects (cost and availability) will more likely than not be determined by the invisible 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 and experts 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 accepted and expected by our patients due to aggressive marketing or clinical relevance, incorporating the technology into one’s practice may not be entirely necessary but prudent.

There are many questions yet to be answered definitively regarding CBCT.

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?
6. If the patient refuses a CBCT and the dentist believes a CBCT is necessary for successful case completion, must the dentist complete the case without the CBCT study or can he refuse 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 others) act upon the industry to account for the powerful influence CBCT has on treatment planning and diagnosis of patients. While recognizing that all that glitters is not gold, CBCT may soon represent a new gold standard by which many cases will be judged.

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