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 in just a few years, 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 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 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 dental 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 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.

No database exists to search verbatim 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 evidence 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:

- 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.

A preponderance of evidence and expert opinion are required to establish 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. The advancement of any technology involves many facets of dentistry.

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 Housesfield unit, the newly 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 Inter- societal 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 Daubert criteria for acceptance as a standard of care technology.

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 is needed to pass the Daubert standard for a standard of care technology. The question is whether CBCT technology has sufficiently evolved to meet the Daubert standard.

Cone Beam Computed Tomography (CBCT) technology produces multi-planar images of a small volume of the jaw. These volumetric images are acquired with lower radiation exposure than is required for traditional orthopantomograms and digital radiography. Additionally, the images are produced in a shorter time than traditional panoramic radiographs. The images can be rotated on a large screen in “real time” to provide the dentist with a three-dimensional view of the anatomy.

“...a technology which not only has significant advantages but also has a noteworthy ‘wow’ factor.”

In the United States, the concept of standards of care may be local, regional, or national. Standards of care may include such language as: ‘are appropriate definition for standard of care’, ‘should be considered in determining whether the methodology is valid,’ ‘the expert believes to be relevant,’ ‘the absence of CBCT is not de facto evidence of lack of a standard of care imaging,’ and ‘the fact that 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.

A preponderance of evidence and expert opinion are required to establish 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. The advancement of any technology involves many facets of dentistry.

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 Housesfield unit, the newly 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 Inter- societal 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 Daubert criteria for acceptance as a standard of care technology.

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 is needed to pass the Daubert standard for a standard of care technology. The question is whether CBCT technology has sufficiently evolved to meet the Daubert standard.

In the United States, the concept of standards of care may be local, regional, or national. Standards of care may include such language as: ‘is appropriate definition for standard of care’, ‘should be considered in determining whether the methodology is valid,’ ‘the expert believes to be relevant,’ ‘the absence of CBCT is not de facto evidence of lack of a standard of care imaging,’ and ‘the fact that 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.

A preponderance of evidence and expert opinion are required to establish 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. The advancement of any technology involves many facets of dentistry.

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 Housesfield unit, the newly 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 Inter- societal 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 Daubert criteria for acceptance as a standard of care technology.

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 is needed to pass the Daubert standard for a standard of care technology. The question is whether CBCT technology has sufficiently evolved to meet the Daubert standard.

In the United States, the concept of standards of care may be local, regional, or national. Standards of care may include such language as: ‘is appropriate definition for standard of care’, ‘should be considered in determining whether the methodology is valid,’ ‘the expert believes to be relevant,’ ‘the absence of CBCT is not de facto evidence of lack of a standard of care imaging,’ and ‘the fact that 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.

A preponderance of evidence and expert opinion are required to establish 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 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.
in literature pertains to the words cone beam CT, cone beam CT + den-

Only prevalent and pertinent of this new value in the formation of a name or an expert (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 or why an unfortunate outcome occurred. Additionally, CBCT provides powerful and easily understandable images for laypersons.

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 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 implants, cone beam CT + orthodontics, cone beam CT + oral surgery, cone beam CT + endodontics in the search line. The results are shown in Table 1.

<table>
<thead>
<tr>
<th>CBCT</th>
<th>CBCT + dental</th>
<th>CBCT + dental implant</th>
<th>CBCT + orthodontics</th>
<th>CBCT + oral surgery</th>
<th>CBCT + endodontics</th>
</tr>
</thead>
<tbody>
<tr>
<td>535</td>
<td>1997</td>
<td>627</td>
<td>203</td>
<td>104</td>
<td>313</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 1


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 organisations of bodies of those disciplines in dentistry who employ the technology to treat patients. In dentistry, the dental practitioners most involved in the use 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 73 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 Art of Dentistry is an important piece of information to treat patients. In dentistry, the dentist practitioners most involved in the use 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 73 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 Art of Dentistry is an important piece of information to treat patients. In dentistry, the dentist practitioners most involved in the use of CBCT in patient care include general dentists, oral and maxillofacial surgeons, endodontists, oral and maxillofacial radiologists, orthodontists, and periodontists.

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 2013. The AAOMS has offered continuing education in the use and application of CBCT for patient care as far back as 2013. The AAOMS has offered continuing education in the use and application of CBCT for patient care as far back as 2013.

The American Society of Endodontists (AAE) and the American Association of Oral and Maxillofacial Surgery (AAOMS) have released an official position paper on CBCT. This paper makes many important points, such as limiting the cone beam imaging 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 endodontic treatment planning should be limited to the assessment and treatment of complex conditions.” The article then lists out the design, utilisation, and limitations of “complex conditions.” In summarisation, 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 Endodon-
tics in 2003. The American Association of Endodontists sponsored continuing education in endodontic related CBCT on their website and the organisation deemed value in incorporating CBCT into endodontics as it relates to modern endodontics. Most residency programmes include CBCT education in their endodontic residency programmes. A review of the literature shows CBCT is a prominent standard of care, those in endodontic 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 position papers. Recommendations, guidelines, and position papers can influence the behaviour of dentists in the practice of their discipline. As the practice of the discipline changes in response to many factors including but not limited to court verdicts, expert testimony, legislation, treatment guidelines, cost of the technology, and reimbursement by third party payers, the recommendations, guidelines, and position papers may evolve the treatment of CBCT into a standard of care. Thus, in 2014 the professional organisations that comprise dentistry may not formally declare CBCT is the standard of care in all cases, but these organisations do recognise the influence CBCT is having on the profession.
Exhibition  Live Product Presentations  Hands-on Workshops  Printed Reference Guide  Coffee With the Experts

22-24 05  Athens
24-27 09  Shanghai
28 09 - 01 10  Moscow
01 - 03 10  Budapest
30 10 - 01 11  Istanbul
30 11 - 02 12  New York

www.DDSWorldShow.com

Organized by Dental Tribune International,
Dental Tribune International  |  Holbeinstraße 29  |  04329 Leipzig  |  Germany
T  +49 341 48474 134  |  F  +49 341 48474 173  |  E  info@digitaldentistryshow.com  |  W  www.DDSWorldShow.com
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 (purchase 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 ownership 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 dentist purchase the machines and more third party non-dentist owned imaging centres enter the market. More dentist 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 (OMSNIC and MedPro) have influenced the evolution of CBCT as a standard of care by offering coverage for CBCT owner/operators commensurate with the level of risk to which the owner/operator are exposed. Were CBCT studies believed to be of little value or represent minimal risk these leaders in the dental malpractice industry would not offer such coverage. Additionally OMSNIC requires the owner/operator to have CBCT images interpreted by a dental or medical radiologist to minimise risk.

Multispecialty use and recognition

Dentistry has nine recognised specialties, four (oral and maxillofacial surgery, endodontics, oral and maxillofacial radiology, and orthodontics) and the American Dental Association have produced literature to address the impact of CBCT on patient care. Of the remaining five specialties, periodontics and prosthetics could logically be appropriate groups to produce a position paper on CBCT given their members participation in dental implant treatment of patients. Paediatric dentistry may soon provide a position paper once long-term studies have been done to assess the risk versus benefit analysis with respect to the total overall radiation dose and its effect on the paediatric population. The specialty of dental public health is unlikely to weigh on the matter.

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/CLP surgeons, and OMFS trauma surgeons. These medical disciplines recognise the high quality three dimensional detail CBCT provides and assists doctors in the treatment planning and diagnosis of their patients. Such widespread and multidisciplinary applications of CBCT imaging contributes to CBCT becoming a new standard of care.

CBCT in the dental culture

Many in the dental profession acknowledge the benefit of 3D imaging to patients and doctors. There is little dispute that CBCT provides superior representation of the anatomy versed 2-D plain films. Darwin stated clearly any organism which in any way adds to the enjoyment of life or facilitates the production of its kind will tend to be preserved through the long succession of generations. As the present day canal versus 2-D periapical and panoramic film, CBCT in the dental culture becomes a standard of care, cost, availability, legal, and patient expectations.