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 expanded 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, there is a known or potential error in CBCT. The widespread acceptance within a field of a new technology has been subjected to peer review, and there is a known or potential error. Furthermore, the existence of maintenance may allow others in the profession to separate, identify, and distinguish the extraordinary to the ordinary. As methods and techniques in patient care improve, an appropriate definition for standard of care must be 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In many jurisdictions and in Federal court, the Frey standard is superseded by the Daubert standard.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 expert testimony is by definition an opinion. 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 provide the opinion. Experts are appointed 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, 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 examination will begin, but not limited to: chart notes, radiographic studies, depositions, and
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only prevalent and pertinent but of significant importance in the value of an opinion by 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 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 of 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, 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 listed in Table 1.

Table 1

<table>
<thead>
<tr>
<th>Key words in search</th>
<th>Number of articles</th>
<th>Year article first appeared</th>
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<tr>
<td>CBCT</td>
<td>577</td>
<td>2001</td>
</tr>
<tr>
<td>CBCT + dental</td>
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<td>2002</td>
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<tr>
<td>CBCT + dental implant</td>
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<tr>
<td>CBCT + oral surgery</td>
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<tr>
<td>CBCT + endodontics</td>
<td>313</td>
<td>2001</td>
</tr>
</tbody>
</table>

Trends & Applications

The American Association of Orthodontists (AAO) has released an optional position paper on CBCT. This paper makes many important points, such as limiting the continuous exposure to minuscule 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 first appeared in the literature in 2001. The American Association of Endodontists sponsor continuing education in endodontic related CBCT on their website and the organisation devotes valuable time and resources to CBCT as it relates to modern endodontics. Most residencies (44 of 47) in endodontics provide CBCT for patient care.

Literature pertaining to the use of CBCT in endodontics first appeared in the Journal of Endodontics in 2003. The American Association of Endodontists sponsored continuing education in endodontic related CBCT on their website and the organisation devotes valuable time and resources 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 AARDORR devotes considerable effort to endodontic education relating to CBCT both on its website, through CT courses, and its annual meeting programme. The AARDORR has published guidelines in Radiology incorporate CBCT education and training into the resident curriculum.

The tremendous value of anatomic truth in complex orthodontic cases is illustrated with alignment, cleft lip and palate, impacted teeth, and maxillofacial deformities is widely recognised and discussed in the literature. Review of the literature and the dental literature, the AARDORR has approved an official position paper on CBCT. This position paper on CBCT in oral surgery 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 per cent of orthodontic programmes have access to CBCT.
- 75 per cent of programmes report “regular” use of CBCT in patient di-agnosis.
- Areas of CBCT use focuses on diagnosis and treatment planning for: impacted teeth, craniofacial anomalies, TAD placement, TMJ assessment, airway analysis, and maxillofacial development.

Literature discussing CBCT in endodontics first appeared in the JAP journal over a decade ago. The American Association of Periodontal-visit annual meeting agenda and the Journal of Periodontology demon-strate a heavy influence of CBCT in the field of periodontics. All post-doctoral US periodontal programmes use CBCT in patient care.

The International Congress of Oral Implantologists (ICOI), the world’s largest dental implant organisa-tion 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, 3D evaluation of alveolar ridge topography, proximity to vital anatomic structures, and fabri-ca tion 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 position papers are used by professionals to influence the practice of the discipline. As the practice of the discipline changes in response to many factors including, but not limited to court verdicts, expert testimony, litigation, reimbursement guidelines, 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 2010 the professional organisations that comprise dentistry may not formally declare CBCT is the standard of care. Two organisations in a survey performed by the author and others 2012 general practice residents and advanced education in general dentistry (AEGD) programmes have access to CBCT, 54 PDs (87 per cent) program directors (PDs) re-sponded affirmatively when asked if CBCT was used in patient care by their residents. The author also surveyed 102 PDs in oral and maxillofacial programmes in the US. Fifty-four PDs responded. Of the 54 PDs responding 47 (87 per cent) affirmatively when asked if CBCT was used in patient care by their residents. In a phone survey of endodontic residencies, 44 of 47 PDs indicated their residents use CBCT in patient care. All seven ADA-approved oral and maxillofacial programmes have access to CBCT; these organisations do recognise the influence CBCT has 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$350,000 range. As any emerging technology, advances create a secondary market for slightly used machines. Each new generation of CBCT technology reduces the CBCT machine of only a few years ago slightly out-of-date, de-creasing value and increasing the potential for secondary market Readings and applications to two dimensional films. As time progresses and advances continue to be made in technology readers of the new machines demonstrate superior, the slightly non- modern machine will represent a significant benefit in the market of new technology readers. The dentist versus 2-D radiography, while not burdening the dentist
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with significant cost. This will un-
doubtedly 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 gener-
at 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 own-
ing and operating a CBCT device
is to be the outsourcing of the study
to a third party (dentist or facility)
and insourcing the software neces-
sary to employ the images in treat-
ment planning and diagnosis.

CBCT machines are becoming
ubiquitous as more dentist pur-
chase the machines and more third
party non-dentist owned imaging
centres enter the market. Since
party non-dentist owned imaging
chase the machines and more third
parties traditionally the last to embrace
ment planning and diagnosis.

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ary to employ the images in treat-
ment planning and diagnosis.

Two of the major malpractice
carriers of the insurance industry
(OMNSIC and MedPro) have in-
flamed the evolution of CBCT
with new CPT codes. This has
influenced the adoption of CBCT
as a new standard of care by offering
coverage for CBCT owner/opera-
tors commensurate with the level
of risk to which the owner/opera-
tors are exposed. Were CBCT studies
believed to hold little value or
represent minimal risk these lead-
ers in the dental malpractice indus-
try would not offer such coverage.
Additionally OMNSIC requires the
owner/operator to have CBCT im-
ages interpreted by a dental or med-
ical radiologist to minimise risk.

Multispecialty use and
recognition

Dentistry has nine recognised
specialties; four (oral and maxillo-
facial 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 re-
maining five specialties, periodon-
tics and prosthodontics 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
the long-term studies have been
done to assess the risk versus ben-
efits 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 wide-
spread and recognised by medical
disciplines such as plastic and re-
constructive surgery, IHN, Crano-
facial/CLP surgeons, and OMFS
trauma surgeons. These medical dis-
clines recognise the high quality
three dimensional detail CBCT pro-
vides and assists doctors in the
preoperative planning and diagnosis
of their patients. Such widespread
and multidisciplinary appreciation 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 CBCT
imaging to patients and doctors.
There is little dispute that CBCT
provides superior representation
of the anatomicverues Oralanfilms.
Quality of product acknowledged,
at least four aspects of CBCT must
work their way through the den-
tal culture before CBCT becomes
a standard of care: cost, availability,
legal, and patient expectations.

Two of these aspects (cost and avail-
ability) will more likely be 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 pa-
tients and insurance companies
are willing to pay. The third (legal)
will be slowly determined in the
court systems as attorneys and ex-
erts 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 prac-
tice may not be wise if cost exceeds
benefits both clinically and finan-
cially. As CBCT becomes accepted
and expected by our pa-
tients 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 inter-
pretation necessary or simply
a single plane?
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 suffi-
cient 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 reper-
cussions?

Lastly, as mentioned earlier, stan-
dard 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 stan-
dard of care in dentistry is adapting
to CBCT as forces (legal, financial,
clinical, and other) act upon the
industry to account for the
powerful influence CBCT has on
the treatment planning and diagnosis
of patients. While recognising that all
that glitter is not gold, CBCT may
soon represent a new gold standard
by which many cases will be judged.

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necessary but prudent.”