



Project Deliverable

Project number: 212246	Project Acronym: SEDENTEXCT	Project title: Safety and Efficacy of a New and Emerging Dental X-ray Modality
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Title: Systematic review complete
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Dissemination level:		
PU	Public	X
PP	Restricted to other programme participants (including the Commission)	
RE	Restricted to a group defined by the consortium (including the Commission)	
CO	Confidential, only for members of the consortium (including the Commission)	

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Abstract:

The aim of Work package 1 is to develop evidence-based guidelines on use of CBCT in dentistry, including referral criteria, quality assurance guidelines and optimisation strategies. Guideline development uses systematic review and established methodology, involving stakeholder input.

As a first step in this process, a systematic review was conducted of scientific literature related to CBCT in dentistry. A multidisciplinary team was formed from individuals from all Partners who identified key topic areas for review. The protocol for the systematic review was further refined by setting a standard that each item of literature would be reviewed by at least two individuals, with a mix of specialists according to the topic area. Papers designated as “case reports/ case series”, that would clearly not satisfy inclusion criteria for diagnostic accuracy studies, would still be included in the review, undergoing a less rigorous review procedure.

A robust search strategy was eventually defined after repeated variations, yielding 241 papers (by September 2008). An ongoing update process of papers has been followed. Three proformas were devised to allow critical appraisal and grading of evidence obtained. Two scientists performed appraisal of each paper.

The systematic review has yielded the evidence required to allow the development of provisional evidence-based guidelines for CBCT, the next stage in Work package 1.

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1. The Context

1.1: SEDENTEXCT Aims and objectives

The aim of this project is the acquisition of the key information necessary for sound and scientifically based clinical use of dental Cone Beam Computed Tomography (CBCT). In order that safety and efficacy are assured and enhanced in the 'real world', the parallel aim is to use the information to develop evidence-based guidelines dealing with justification, optimisation and referral criteria and to provide a means of dissemination and training for users of CBCT. The objectives and methodology of the collaborative project are:

1. To develop evidence-based guidelines on use of CBCT in dentistry, including referral criteria, quality assurance guidelines and optimisation strategies. Guideline development will use systematic review and established methodology, involving stakeholder input.
2. To determine the level of patient dose in dental CBCT, paying special attention to paediatric dosimetry, and personnel dose.
3. To perform diagnostic accuracy studies for CBCT for key clinical applications in dentistry by use of in vitro and clinical studies.
4. To develop a quality assurance programme, including a tool/tools for quality assurance work (including a marketable quality assurance phantom) and to define exposure protocols for specific clinical applications.
5. To measure cost-effectiveness of important clinical uses of CBCT compared with traditional methods.
6. To conduct valorisation, including dissemination and training, activities via an 'open access' website.

At all points, stakeholder involvement will be intrinsic to study design.

1.2: Work package 1 (WP1) objectives

- to perform a systematic review of CBCT based on 'dose and risk', 'diagnostic accuracy' and 'quality assurance'
- to develop provisional guidelines to input into WP6.
- to incorporate knowledge obtained from the results of SEDENTEX CT study
- to develop definitive referral criteria and guidelines on quality assurance, optimization to input into WP6.

1.3: Deliverable 1.1

"Systematic review complete". This Deliverable forms the basis of the WP1, being the acquisition of the information required to develop provisional guidelines on the use of CBCT in dentistry.

2. The Methodology

This section describes the work performed.

2.1: The establishment of the Guideline Development Panel (GDP)

A multidisciplinary team was formed from individuals from all Partners with the exception of Partner 4. The GDP includes a variety of stakeholders, including dentists, dental radiologists, medical physicists and oral and maxillofacial surgeons (from UNIMAN and beneficiaries NKUA, UMFCLUJ, KUL, MAHOD and VU), representing the many specialties that routinely work with CBCT. The membership was derived from colleagues attending the first SEDENTEXCT meeting held in Leuven in January, 2008. Following the Description of Work, key topic areas were confirmed as needing to be covered in the review. These are summarised below:

- Dose and Risk
- Diagnostic Reference Levels
- Optimisation
- Quality standards
- Cost/Benefit Analysis
- Diagnostic Accuracy Studies
- Case reports/ case series

The protocol for the systematic review was further refined at the Leuven meeting by setting a standard that each item of literature would be reviewed by at least two individuals, with a mix of specialists according to the topic area (i.e. two clinicians for diagnostic accuracy studies; physicists for dosimetry studies, etc.). A decision was made that papers designated as “case reports/ case series”, that would clearly not satisfy inclusion criteria for diagnostic accuracy studies, would still be included in the review, requiring a different assessment proforma.

2.2: Identification of the Literature

It was decided that the Panel would follow SIGN (2004) methodology. The WP1 Lead, in combination with a specialist in Evidence-based Oral Health Care performed an initial search for any existing guidelines. Searches were then performed in:

- the FDI guideline database (www.fdiworldental.org)
- the National Guidelines Clearing House (www.guideline.gov)
- Medline
- Embase
- Scopus
- Web Science.

The search strategy has been designed for use on MEDLINE (1950-) and adapted for use on the following:

- EMBASE (1980)
- Cochrane Oral Health Group's Trials Register
- The Cochrane Central Register of Controlled Trials (Central)
- Web of Science
- Scopus
- UK Clinical Research Network
- Clinical Trials.gov
- Register of Controlled Trials (www.controlled-trials.com)
- NICE guidelines (www.nice.org.uk)
- FDI World Dental Federation Guidelines (www.fdiworldental.org).

Also 'grey literature' has been evaluated using SIGLE (until 2005) (opensigle.inist.fr/) and FADE (www.fade.nhs.uk/).

The initial 'scoping' search strategy was found to be unhelpful as it was not specific in identifying papers relating to the dental uses of CBCT. Numerous publications relating to non-dental use/ radiotherapy were included. The refinement of the search strategy to derive those papers related to dental cone beam computed tomography contributed to a loss of four weeks overall. However, the Work Package lead was able to derive a small number of dental papers from each of the eleven 'scoping' searches undertaken. The search strategy was finally refined using controlled vocabulary e.g. MeSH and free text words. This (Table 1) proved successful in including all papers related to the use of CBCT.

Table 1: Search strategy developed for use in the SEDENTEXCT project

1	cone beam computed tomography .mp
2	volumetric radiography. mp
3	volumetric tomography.mp
4	digital volumetric tomography.mp
5	digital volumetric tomography.mp
6	digital volume tomography
7	cbct.mp
8	qcbct.mp
9	cone-beam ct.mp
10	cone beam imaging .mp
11	cone-beam.mp
12	volume ct.mp
13	volumetric ct.mp
14	or/1-13
15	(dental or dentistry).mp [mp=title, original title, abstract, name of substance word, subject heading word]
16	exp dentistry/
17	(intra-oral or intraoral).mp [title, original title, abstract, name of substance word, subject heading word]
18	oral surgery.mp. or exp surgery, oral/
19	endodontics\$.mp. or exp endodontics
20	orthodontics\$. mp. or exp orthodontics
21	(periodontic\$ or periodontology).mp.or exp periodontics/

22	exp dental caries/
23	maxillofacial.mp
24	15 or 16 or 17 or 18 or 19 or 20 or 21 or 22 or 23
25	14 and 24

The results of searches were imported into Endnote (version 9) and coded according to the key topic areas.

The initial search strategy was completed one month late (M1.2), but the search itself was completed on time (M1.3). Searches have been repeated each month to provide an update on the literature. The screening of relevant papers has provided the Guideline Development Group with a total of 241 papers as of the end September 2008. These papers have been categorised as detailed in Table 2:

Table 2: Details of literature classification into topic areas

Category of paper	Number
Diagnostic Accuracy	50
Dose and Risk	16
Quality Assurance	26
Optimisation	3
Case reports, case series	146

2.3: Data extraction/quality assessment

Papers for review were posted as PDF files on the website intranet in batches, allocated to the Guideline Development Panel members (1 and 2).

Figure 1: Page from SEDENTEXCT intranet showing reviewers in WP1



Figure 2: Example page from SEDENTEXCT intranet showing list of papers for review allocated to one of the reviewers

The screenshot shows the SEDENTEXCT Project Intranet interface. At the top, there is a navigation bar with links for 'home', 'project', 'stakeholders', 'partners', and 'intranet'. The main header displays the SEDENTEXCT logo and the title 'Project Intranet'. Below this, the current folder path is shown as 'Repository of Documents / WP1 Review / Vivian Rushton'. The page is titled 'Diagnostic Accuracy' and includes a prompt to download a 'review form'. A table lists four papers for review, each with its title, author, journal, reference, PDF size, and a download icon.

Title	PDF size	Download
First Author: Haiter-Neto Title: Diagnostic accuracy of cone beam computed tomography scans compared with intraoral image modalities for detection of caries lesions Journal: Dento-Maxillo-Facial Radiology Ref: 2008:37;18-22	76 KB	
First Author: Korbmacher Title: Value of two cone-beam computed tomography systems from an orthodontic point of view Journal: Journal of Orofacial Orthopedics Ref: 2007:68;278-89	544 KB	
First Author: Lofthag-Hansen Title: Limited cone-beam CT and intraoral radiography for the diagnosis of periapical pathology Journal: Oral Surgery Oral Medicine Oral Pathology Oral Radiology & Endodontics Ref: 2007:103;114-9	303 KB	
First Author: Maal Title: The accuracy of matching three-dimensional photographs with skin surfaces derived from cone-beam computed tomography Journal: International Journal of Oral & Maxillofacial Surgery Ref: 2008:37;641-646	996 KB	


Proformas for data extraction were developed and piloted by members of the Manchester team. These were also downloadable from the project intranet (<http://www.sedentexct.eu/intranet>).

In the “Description of Work”, the completion of the systematic review (D1.1) was planned for Month 9 (30 September 2008). In view of the delays detailed in the Annual Report of the project, the actual Delivery date was at the end of Month 13 (31 January 2009).

2.4: Forthcoming work and input to the project

The systematic review has now been fed into the process of Provisional Guideline Development, as described in the “Description of Work”. A two day meeting has been arranged of the Guideline Development Panel in March 2009, at which Provisional Guidelines will be formulated, leading to Deliverable 1.2 of the project.

Appendix 1: Review proforma for Diagnostic Accuracy studies

 SEDENTEXCT

Checklist for Assessing a Diagnostic Accuracy Study

STUDY (Author, year)..... Article number.....

Reviewer.....

Study type

Systematic Review	<input type="checkbox"/>
Experimental randomized	<input type="checkbox"/>
Experimental non randomized	<input type="checkbox"/>
Cohort	<input type="checkbox"/>
Case-control	<input type="checkbox"/>
Survey	<input type="checkbox"/>
Case-series/report	<input type="checkbox"/>
Laboratory	<input type="checkbox"/>
Expert opinion	<input type="checkbox"/>
Other	<input type="checkbox"/>

Source of funding.....

1. Is the purpose of the use of CBCT clearly specified? YES
NO

If yes please specify (e.g. orthodontics, maxillofacial, forensic, caries diagnosis...)

3. Type of CBCT equipment used:

Name of manufacturer.....

Name of equipment.....

Details of equipment: FOV:.....
kV:.....
µA:..... size / resolution:.....

4. Was there a reference standard? YES
NO

If YES, please tick as appropriate:

Histology	<input type="checkbox"/>
Surgical finding/ clinical finding in vivo	<input type="checkbox"/>
Direct visualization in vitro	<input type="checkbox"/>
Micro CT	<input type="checkbox"/>
Consensus of observers	<input type="checkbox"/>
If so, how many observers.....	<input type="checkbox"/>
CBCT itself	<input type="checkbox"/>
Other method used	<input type="checkbox"/>
Please give details.....	

5. Did the whole sample or a random selection of the sample receive verification using the reference standard? YES
NO
Unclear

6. How many observers were involved in the evaluation?

7. Was intra-observer variability assessed YES
NO

If yes, give value.....

What statistical test was used?

Kappa	<input type="checkbox"/>
Bland and Altman	<input type="checkbox"/>
Intra-class correlation	<input type="checkbox"/>
Not stated/unclear	<input type="checkbox"/>

8. Was inter-observer variability assessed YES
NO

If yes, give value.....

What statistical test was used?

Kappa	<input type="checkbox"/>
Bland and Altman	<input type="checkbox"/>
Intra-class correlation	<input type="checkbox"/>
Not stated/unclear	<input type="checkbox"/>

9. Were the samples/patients selected either as a consecutive series or randomly, from a clearly defined study population? YES
NO
Unclear

10. Were CBCT and its comparison/reference standard measured independently (blind) of each other? YES
NO
Unclear

11. Were CBCT and its comparison/reference standard measured as close together in time as possible? YES
NO
Unclear

12. Are results reported for all samples/patients that entered the study? YES
NO
Unclear

13. Was a pre-test diagnosis made and reported? YES
NO
Unclear

Results (Not all data will be presented, please complete as appropriate)

Number of patients/samples.....

Prevalence of disease in the population from which patients were selected.....

REFERENCE STANDARD			
		+VE	-VE
CBCT	+VE	TP	FP
	-VE	FN	TN

Which of the following does the study report? (In each case please state value and 95%CI when available)

Sensitivity of CBCT

Specificity of CBCT

Positive predictive value

Negative predictive value


Likelihood ratios

ROC analysis

Other.....

OVERALL ASSESSMENT			
Do you trust the results of this study?	Fully (**)	Partially (+)	No (-)
Additional comments			

Appendix 2: Review proforma for general use

 GENERAL ASSESSMENT FORM FOR SEDENTEXCT PUBLICATIONS					
Study Details	Study Design	Aims and methods	Results and Author's Conclusions	Comments	Suggested Grade: A-E
Study number First author/year		Aim: Method:	Results: Conclusions:	Strengths: Weaknesses:	

Appendix 3: Review proforma for Case studies and case reports



CASE REPORT AND CASE SERIES REVIEW

Paper No:	
First author and year of publication:	
Clinical area:	
Number of cases presented:	
Case selection: 1. Consecutive 2. Non-consecutive 3. Unknown/unclear	
Implications of the case are important? Yes No	
Uniqueness of case(s):	
Implications of the case are clearly delineated?	
Literature review is adequate?	
Important addition to the literature? Yes No	
Key points:	
Overall assessment: A. Valuable information from consecutive case series B. Valuable information from case series where selection process is unclear C. Equivocal value (small series/ unclear or no apparent systematic selection process) D. Adds little or nothing to existing knowledge	

Appendix 4: reviewed papers

"Erratum: Dosimetry of 3 CBCT devices for oral and maxillofacial radiology: CB Mercuray, NewTom 3G and i-CAT (*Dentomaxillofacial Radiology* (2006) 35 (219-226) 10.1259/dmfr/14340323)."

(2007). "The evolving e-practice. Predictable visualization and imaging using three-dimensional cone beam technologies." *Practical Procedures & Aesthetic Dentistry: Ppad* **19**(9): 546-8.

Abdelkarim, A., R. Green, et al. (2008). "Craniofacial polyostotic fibrous dysplasia: a case report and review of the literature." *Oral Surgery Oral Medicine Oral Pathology Oral Radiology & Endodontics* **106**(1): e49-55.

Aboudara, C. A., D. Hatcher, et al. (2003). "A three-dimensional evaluation of the upper airway in adolescents." *Orthodontics & Craniofacial Research* **6 Suppl 1**: 173-5.

Agbaje, J., J. R., et al. (2008). "Bone healing after dental extractions in irradiated patients: a pilot study on a novel technique for volume assessment of healing tooth sockets." *Clinical Oral Investigations* (Epub).

Agbaje, J. O., R. Jacobs, et al. (2007). "Volumetric analysis of extraction sockets using cone beam computed tomography: a pilot study on ex vivo jaw bone." *Journal of Clinical Periodontology* **34**(11): 985-90.

Akdeniz, B. G., H.-G. Grondahl, et al. (2006). "Accuracy of proximal caries depth measurements: comparison between limited cone beam computed tomography, storage phosphor and film radiography." *Caries Research* **40**(3): 202-7.

Almog, D. M., J. LaMar, et al. (2006). "Cone beam computerized tomography-based dental imaging for implant planning and surgical guidance, Part 1: Single implant in the mandibular molar region." *Journal of Oral Implantology* **32**(2): 77-81.

Al-Rawi, W. T., R. Jacobs, et al. (2007). "Evaluation of web-based instruction for anatomical interpretation in maxillofacial cone beam computed tomography." *Dento-Maxillo-Facial Radiology* **36**(8): 459-64.

Alves, P. V. M., A. M. Bolognese, et al. (2007). "Three-dimensional computerized orthognathic surgical treatment planning." *Clinics in Plastic Surgery* **34**(3): 427-36.

Angelopoulos, C. (2008). "Cone beam tomographic imaging anatomy of the maxillofacial region." *Dental Clinics of North America* **52**(4): 731-52.

Angelopoulos, C., S. Thomas, et al. (2008). "Comparison between digital panoramic radiography and cone-beam computed tomography for the identification of the mandibular canal as part of presurgical dental implant assessment." *Journal of Oral & Maxillofacial Surgery* **66**(10): 2130-5.

Anonymous (2007). "The evolving e-practice. Predictable visualization and imaging using three-dimensional cone beam technologies." *Practical Procedures & Aesthetic Dentistry: Ppad* **19**(9): 546-8.

Arai, Y., E. Tammisalo, et al. (1999). "Development of a compact computed tomographic apparatus for dental use." *Dento-Maxillo-Facial Radiology* **28**(4): 245-8.

Araki, K., K. Maki, et al. (2004). "Characteristics of a newly developed dentomaxillofacial X-ray cone beam CT scanner (CB MercuRay): system configuration and physical properties." *Dento-Maxillo-Facial Radiology* **33**(1): 51-9.

Araki, M., K. Hashimoto, et al. "Radiographic features of enostosis determined with limited cone-beam computed tomography in comparison with rotational panoramic radiography."

Araki, M., S. Kameoka, et al. (2007). "Usefulness of cone beam computed tomography for

odontogenic myxoma." Dento-Maxillo-Facial Radiology **36**(7): 423-7.

Aranyarachkul, P., J. Caruso, et al. (2005). "Bone density assessments of dental implant sites: 2. Quantitative cone-beam computerized tomography." International Journal of Oral & Maxillofacial Implants **20**(3): 416-24.

Baba, R., Y. Konno, et al. (2002). "Comparison of flat-panel detector and image-intensifier detector for cone-beam CT." Computerized Medical Imaging & Graphics **26**(3): 153-8.

Baba, R., K. Ueda, et al. (2004). "Using a flat-panel detector in high resolution cone beam CT for dental imaging." Dento-Maxillo-Facial Radiology **33**(5): 285-90.

Ballrick, J. W., J. M. Palomo, et al. (2008). "Image distortion and spatial resolution of a commercially available cone-beam computed tomography machine." American Journal of Orthodontics & Dentofacial Orthopedics **134**(4): 573-82.

Balshi, T. J., G. J. Wolfinger, et al. "No bone solutions for the severely atrophic maxilla." Dentistry Today **27**(3): 94.

Barone, A., U. Covani, et al. (2003). "Radiographic bone density around immediately loaded oral implants." Clinical Oral Implants Research **14**(5): 610-5.

Bartling, S. H., O. Majdani, et al. (2007). "Large scan field, high spatial resolution flat-panel detector based volumetric CT of the whole human skull base and for maxillofacial imaging." Dento-Maxillo-Facial Radiology **36**(6): 317-27.

Baumrind, S., S. Carlson, et al. (2003). "Using three-dimensional imaging to assess treatment outcomes in orthodontics: a progress report from the University of the Pacific." Orthodontics & Craniofacial Research **6 Suppl 1**: 132-42.

Bhatavadekar, N. B. and D. W. Paquette (2008). "Long-term follow-up and tomographic assessment of an intrabony defect treated with enamel matrix derivative." Journal of Periodontology **79**(9): 1802-8.

Blake, F. A. S., M. Blessmann, et al. (2008). "A new imaging modality for intraoperative evaluation of sinus floor augmentation." International Journal of Oral & Maxillofacial Surgery **37**(2): 183-5.

Blessmann, M., P. Pohlenz, et al. (2007) "Validation of a new training tool for ultrasound as a diagnostic modality in suspected midfacial fractures." Int J Oral Maxillofac Surg **36**(6):501-6.

Boeddinghaus, R. and A. Whyte (2008) "Current concepts in maxillofacial imaging." Eur J Radiol **66**(3):396-418.

Bousquet, F. and M. Joyard (2008). "Surgical navigation for implant placement using transtomography." Clinical Oral Implants Research **19**(7): 724-30.

Bryant, J. A., N. A. Drage, et al. (2008). "Study of the scan uniformity from an i-CAT cone beam computed tomography dental imaging system." Dento-Maxillo-Facial Radiology **37**(7): 365-74.

Cattaneo, P. M. and B. Melsen (2008). "The use of cone-beam computed tomography in an orthodontic department in between research and daily clinic." World Journal of Orthodontics **9**(3): 269-82.

Cavezian, R. and G. Pasquet (2008). "[Imagery and orthodontics: trends, present and future]." Orthodontie Francaise **79**(1): 3-12.

Cevidane, L. H. S., L. J. Bailey, et al. (2005). "Superimposition of 3D cone-beam CT models of orthognathic surgery patients." Dento-Maxillo-Facial Radiology **34**(6): 369-75.

Cevidane, L. H. S., L. T. J. Bailey, et al. (2007). "Three-dimensional cone-beam computed tomography for assessment of mandibular changes after orthognathic surgery." American Journal of

Orthodontics & Dentofacial Orthopedics **131**(1): 44-50.

Cevidane, L. H. S., M. A. Styner, et al. (2006). "Image analysis and superimposition of 3-dimensional cone-beam computed tomography models." American Journal of Orthodontics & Dentofacial Orthopedics **129**(5): 611-8.

Cha, J.-Y., J. Mah, et al. (2007). "Incidental findings in the maxillofacial area with 3-dimensional cone-beam imaging." American Journal of Orthodontics & Dentofacial Orthopedics **132**(1): 7-14.

Chaushu, S., G. Chaushu, et al. (2004). "The role of digital volume tomography in the imaging of impacted teeth." World Journal of Orthodontics **5**(2): 120-32.

Chen, C. S. K. and J. D. Decker (2007). "CBCT interpretation.[comment]." American Journal of Orthodontics & Dentofacial Orthopedics **132**(3): 277.

Chen, L.-C., T. Lundgren, et al. (2008). "Comparison of different methods of assessing alveolar ridge dimensions prior to dental implant placement." Journal of Periodontology **79**(3): 401-5.

Closmann, J. J. and B. L. Schmidt (2007). "The use of cone beam computed tomography as an aid in evaluating and treatment planning for mandibular cancer." Journal of Oral & Maxillofacial Surgery **65**(4): 766-71.

Cohenca, N., J. H. Simon, et al. (2007). "Clinical indications for digital imaging in dento-alveolar trauma. Part 2: root resorption." Dental Traumatology **23**(2): 105-13.

Cohenca, N., J. H. Simon, et al. (2007). "Clinical indications for digital imaging in dento-alveolar trauma. Part 1: traumatic injuries." Dental Traumatology **23**(2): 95-104.

Cohnen, M., J. Kemper, et al. (2002). "Radiation dose in dental radiology." European Radiology **12**(3): 634-7.

Connor, S. E. J., T. Arscott, et al. (2007). "Precision and accuracy of low-dose CT protocols in the evaluation of skull landmarks." Dento-Maxillo-Facial Radiology **36**(5): 270-6.

Coppenrath, E., F. Draenert, et al. (2008). "Cross-sectional imaging in dentomaxillofacial diagnostics: dose comparison of dental MSCT and NewTom 9000 DVT." Rofo: Fortschritte auf dem Gebiete der Rontgenstrahlen und der Nuklearmedizin **180**(5): 396-401.

Cotton, T. P., T. M. Geisler, et al. (2007). "Endodontic applications of cone-beam volumetric tomography." Journal of Endodontics **33**(9): 1121-32.

Danforth, R. A. (2003). "Cone beam volume tomography: a new digital imaging option for dentistry." Journal of the California Dental Association **31**(11): 814-5.

Danforth, R. A., I. Dus, et al. (2003). "3-D volume imaging for dentistry: a new dimension.[erratum appears in J Calif Dent Assoc. 2003 Dec;31(12):890]." Journal of the California Dental Association **31**(11): 817-23.

Danforth, R. A., J. Peck, et al. (2003). "Cone beam volume tomography: an imaging option for diagnosis of complex mandibular third molar anatomical relationships." Journal of the California Dental Association **31**(11): 847-52.

de Morais, J. A. N. D., C. E. Sakakura, et al. (2007). "A survey of radiographic measurement estimation in assessment of dental implant length." Journal of Oral Implantology **33**(4): 186-90.

de Oliveira, A. E. F., L. H. S. Cevidane, et al. (2009). "Observer reliability of three-dimensional cephalometric landmark identification on cone-beam computerized tomography." Oral Surgery Oral Medicine Oral Pathology Oral Radiology & Endodontics **107**(2): 256-65.

de Oliveira, R. C. G., C. R. Leles, et al. (2008). "Assessments of trabecular bone density at implant

sites on CT images." Oral Surgery Oral Medicine Oral Pathology Oral Radiology & Endodontics **105**(2): 231-8.

Draenert, F. G., E. Coppenrath, et al. (2007). "Beam hardening artefacts occur in dental implant scans with the NewTom cone beam CT but not with the dental 4-row multidetector CT." Dento-Maxillo-Facial Radiology **36**(4): 198-203.

Draenert, F. G., F. Gebhart, et al. (2008). "Imaging of bone transplants in the maxillofacial area by NewTom 9000 cone-beam computed tomography: a quality assessment." Oral Surgery Oral Medicine Oral Pathology Oral Radiology & Endodontics **106**(1): e31-5.

Dula, K., R. Mini, et al. (2001). "The radiographic assessment of implant patients: decision-making criteria." International Journal of Oral & Maxillofacial Implants **16**(1): 80-9.

Eggers, G., J. Klein, et al. (2008). "Geometric accuracy of digital volume tomography and conventional computed tomography." British Journal of Oral & Maxillofacial Surgery **46**: 639-644.

Eggers, G., T. Welzel, et al. (2007). "X-ray-based volumetric imaging of foreign bodies: a comparison of computed tomography and digital volume tomography." Journal of Oral & Maxillofacial Surgery **65**(9): 1880-5.

Enciso, R., A. Memon, et al. (2003). "Three-dimensional visualization of the craniofacial patient: volume segmentation, data integration and animation." Orthodontics & Craniofacial Research **6 Suppl 1**: 66-71; discussion 179-82.

Erickson, M., J. M. Caruso, et al. (2003). "Newtom QR-DVT 9000 imaging used to confirm a clinical diagnosis of iatrogenic mandibular nerve paresthesia." Journal of the California Dental Association **31**(11): 843-5.

Estrela, C., M. R. Bueno, et al. (2008). "A new periapical index based on cone beam computed tomography." Journal of Endodontics **34**(11): 1325-31.

Estrela, C., M. R. Bueno, et al. (2008). "Accuracy of cone beam computed tomography and panoramic and periapical radiography for detection of apical periodontitis." Journal of Endodontics **34**(3): 273-9.

Fan, L.-F., X.-G. Pan, et al. (2008). "[Diagnostic value of dental implants in the posterior maxilla using cone beam computed tomography.]." Shanghai Kou Qiang Yi Xue/Shanghai Journal of Stomatology **17**(5): 548-51.

Fang, Y., M. O. Lagravere, et al. (2007). "Maxillary expansion treatment using bone anchors: development and validation of a 3D finite element model." Computer Methods in Biomechanics & Biomedical Engineering **10**(2): 137-49.

Farman, A. G. (2005). "Applying DICOM to dentistry." Journal of Digital Imaging **18**(1): 23-7.

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