ORIGINAL ARTICLE

THE PLACE OF THE CONE BEAM COMPUTED TOMOGRAPHY IN THE CURRICULA OF MOROCCAN DENTAL SCHOOL

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ABSTRACT

Objective: This study aimed to evaluate the place of Cone Beam Computed Tomography (CBCT) in the pre-doctoral curricula and dental residency training programs among Moroccan dental schools. **Method:** A descriptive cross-sectional study was conducted among teachers and medical specialists in Moroccan public dental schools. A fourteen-question survey form was electronically sent to all teachers as well as medical specialists of dental schools of Casablanca and Rabat. Data processing was done using SPSS software version 16.0. Quantitative variables were described in number and percentage. The qualitative variables were compared using a chi-square test. A p-value less than 0.05 was considered significant. **Result**: 128 questionnaires were sent by e-mail, 59 completed questionnaires were received (46 teachers (78%) and 13 specialist doctors (22%)), with response rate of 47.6%. A low rates concerning the involvement of the CBCT teaching in the courses of dental medicine in Morocco for both students (35.6%) and residents (18.6%). Therefore, the analytical study showed that surgical odontology department was the most involved in the use and prescription of CBCT (66.7%). **Conclusion**: From this study, we observed that the incorporation of CBCT teaching courses in dental faculties in Morocco remains low, hence the need to reflect on strategies to increase the interest of dental school teachers in CBCT so that the laureates of these schools will be able to use this type of examination in daily practice and above all for good purpose.
Keywords: *Education, Dental; radiology; cone beam computed tomography; Schools, Dental ; Morocco ; Learning ; Students, Dental.*

1. INTRODUCTION

In recent years, the rapid growth of computing has led to significant progress in the field of dental imaging. Following the advent of panoramic radiography in 1965 and the medical scanner in the 1970s, radiographic imaging shifted from analogue to digital (computed tomography: CT) with the possibility of two or three-dimensional reconstruction (2D/3D) [1].

Cone Beam or conical beam computed tomography (CBCT) is a new medical imaging tool with multiple applications [2]. More precise than a panoramic X-ray and less radiating than the conventional scanner, it achieves acquisitions of the facial mass in all the planes of the space, offering the possibility of a computer reconstruction in 3D. It is recognized as the sectional reference way in dental-maxillofacial diagnosis imaging [2]. The device consists of an X-ray generator emitting a conically shaped beam of constant width [3]. The movement of cone Beam devices is circular, iso-centric and constant. In the vast majority of cases, the X-ray beam of the CBCT is pulsed. During each angular step, the X-ray beam modulated by the passage of the volume is collected on a detector-most often a flat sensor and more rarely a luminance amplifier called "brightness" - which records a two-dimensional digital image (2D). This reconstruction operation is done from a finite number of digital acquisitions and allows the reconstruction of the volume thanks to the reconstruction algorithms. With the computer tomography (CT), the digitized volume is acquired by the superposition of the cuts; with the CBCT, it is obtained directly by the computer reconstruction from the initial data of 2D projections [4].

Based on the study conducted by Parashar et al., in 2010, which was carried out in England, Australia and the United States in order to evaluate the implementation and incorporation of CBCT teaching in both the predoctoral/undergraduate and postgraduate/residency specialty training curricula in dental schools [5], the purpose of this study was to assess the place of teaching CBCT in Moroccan dental schools, and to determine the importance of the implementation of CBCT courses in the curricula of students and residents in dentistry.

2. MATERIALS AND METHODS

A descriptive cross-sectional study was conducted in a population (n=59) of teachers and medical specialists in Moroccan public dental schools using a simple fourteen-question survey obtained based on the questionnaire used in the study conducted by Parashar and al., in 2010 [5].

The questionnaire was formulated to be short and informative with options to choose "Yes", "No", or "Not Applicable", as answers. Questions from 1 to 5 concerned the personal information of the participants. Questions 6 to 12 assessed the inclusion of CBCT in the predoctoral curriculum, including image orientation and the inclusion of CBCT images in the schools' courses, as well as acquisition and interpretation of the images and application of implant planning software.

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Questions 9 to 13 assessed the inclusion of CBCT acquisition, interpretation, and implant software application in postdoctoral/residency programs. The last question concerned the frequency of cone beam prescription to patients.

The list of e-mail addresses of all members of our sample was obtained from the administrations of the two respective dental schools (Casablanca and Rabat). They were contacted by e-mail and their informed consent was obtained to participate in the study and were asked to inform us once the questionnaire was completed (by answering by e-mail as well) to check their names on the established list.

The survey questionnaire was put online on 02/06/2016 on Google Forms, here is the link: https://docs.google.com/forms/d/14NDOnfxKNa5H6NwhP5XEtRgDhFh8GJPwV3BwSqEtiQ/viewform.

Data processing was done using SPSS software version 16.0 in the Laboratory of Medical Informatics (LIM) at Casablanca medical and pharmacy school, University Hassan II. Quantitative variables were described in number and percentage. The qualitative variables were compared using a chi-square test. A *p*-value less than 0.05 was considered significant. Ethical clearance was obtained from the Ethics Committee of the Casablanca Faculty of Dentistry, University Hassan II.

1. RESULTS

Table 1: The presents the age of the studied population.

	Frequency	Percentages (%)
Age		
20 – 30 years	0	0
30 – 40 years	25	42,4
40 – 50 years	18	30,5
50 – 60 years	16	27,1

Table 2: Distribution of the sample according to the number of years of practice.

	Frequency	Percentages (%)
Number of years of practice		
< 5 years	1	1,7
5 – 10 years	15	25,4
> 10 years	43	72,9

Table 3: The prevalence of teaching the CBCT among dental students.

	Frequency	Percentages (%)
Do you teach 3 dimensional image orientations during the pre-doctoral oral radiology course		
Yes	4	7
No	53	93
Do you include 3 Dimensional Cone Beam images for pre-doctoral oral radiology course		
Yes	21	35,6
No	38	64,4
Do you provide training to dental students to acquire Cone Beam CT scans		
Yes	7	11,9
No	52	88,1
Do you provide training to dental students in the interpretation of cone beam acquisitions		
Yes	15	25,4
No	44	74,6
Do you provide training to dental students to apply implant planning software		
Yes	0	0
No	59	100

Table 4: The prevalence of teaching the CBCT among dental residents

	Frequency	Percentages (%)
Do you provide training to dental residents to acquire Cone Beam CT scans		
Yes	11	18,6
No	48	81,4
Do you provide training to dental residents in the interpretation of cone beam acquisitions		
Yes	11	18,6
No	48	81,4
Do you provide training to dental residents to apply implant planning software		
Yes	0	0
No	59	100

A total of 128 questionnaires were sent by e-mail to all teachers as well as medical specialists of dental schools of Casablanca and Rabat. We received 61 completed questionnaires, of which 2 were excluded because they included missing data. The response rate was 47.6%. A total of 59 teachers and specialist dentists formed the study sample. It consisted of 46 teachers (78%) and 13 specialist doctors (22%). 67.8% of our sample practiced at the dental school in Casablanca, while 32.2% practiced in Rabat. The age of the participants ranged from 30 to 60 years (Table 1). 72.9% of the participants had more than 10 years of exercise (Table 2).

Regarding the integration of the CBCT in the student training program, 93% of the participants stated that they do not teach 3D courses to their students, but 35.6% stated that they teach 3D CBCT courses to their students. Also, 88.1% of participants attested that they do not offer trainings to assimilate the concept of CBCT to students, but 25.4% declared that they provide trainings in CBCT interpretation. However, all the participants declared that they do not offer trainings for the application of implant planning software to students (Table 3).

When the same questions were asked regarding the education of dental residents, only 11 participants (18.6%) reported having a training program for the assimilation of the CBCT concept, the same rate (18.6%) was found for training in the interpretation of CBCT acquisitions. In addition, all participants without exception reported that they did not provide training in the application of implant planning software to their residents. Regarding the prescription of CBCT, only 15.5% responded that they often prescribed it to their patients, 70.7% responded that they sometimes prescribed it, and 13.8% never prescribed it (Table 4).

The analytical results did not show any significant difference between practice locations and dental disciplines with respect to the teaching of 3D images and 3D CBCT image courses to students. Participants from Rabat were more likely to report offering trainings in the assimilation of CBCT concept to their students compared with participants from Casablanca with a significant difference (p = 0.030). And for dental specialties, surgical odontology was the one that obtained the highest rate concerning the presentation of this trainings to students with a significant difference (p = 0.011).
As for the training of doctor residents for the assimilation of the concept of CBCT, there was no significant difference between exercise location (p = 0.149), but between dental specialties, surgical odontology had the highest rate (66.7%) without a significant difference (p = 0.009).

Concerning training students in interpretation of cone beam acquisitions, there was no significant difference between practice location (p = 1,000), once again the surgical specialty had the highest rate (66.7%) in the presentation of these courses to students with a significant difference (p = 0.023).

The results concerning offering this type of trainings to residents showed a higher rate at participants of Rabat (36.8%) compared to those practicing in Casablanca (10.0%) with a significant difference (p = 0.028). However, there was no significant difference between all dental specialties regarding the presentation of this type of trainings to residents (p = 0.177).

Regarding the prescription of CBCT to patients, there was no significant difference between the location of exercise (p = 0.617). However, specialists in surgical odontology were the most likely to prescribe the CBCT to their patients (66.7%), while periodontologists had the highest rate among specialists who do never prescribe the CBCT to their patients (20%) (p = 0.005).

4. DISCUSSION

The use of the cone beam in the practice of dentistry is gaining increasing importance because of its obvious contribution to the diagnosis of a variety of complex clinical cases. This study achieved a response rate of 47.6%. This rate was perceived low compared to the same study conducted in the United States [5] which recorded a response rate of 98%, the study conducted in England [5] with a rate of 94% and the one conducted in Australia [5] with a response rate of 100% response [5]. Smith et al., (2011) [6] has done a similar study among orthodontic residents in the United States and Canada. The latter recorded a response rate of 52.2%. In the study conducted in United States, [7] on the teaching of CBCT to oral and maxillofacial surgery residents the response rate was 53%. However our response rate was higher (29%) then the study of Buchanan et al., (2017) on predoctoral and postdoctoral education on CBCT [8].

Of our 59 participants, 78% were teachers and 22% were medical specialists. Regarding the involvement of 3D image courses in student's teaching program, only 7% of our participants said that they include these courses in the pre-doctoral training program. This result proved to be very poor compared with the same study conducted in the United States [5], which found that 84% of study participants included 3D image courses for their students' training, 67% in England [5] and 100% in Australia [5]. These courses allow students to see the anatomical structures in the 3 planes of space.

Our participants were also asked about the implication of the 3D image of the CBCT in the training program of their students. 35.6% responded yes. Likewise, the result remains low compared with the United States [5], which raised 91%, 80% in England [5] and 71% in Australia [5]. Incorporating the 3D image of the CBCT into X-ray imaging courses will allow students to become familiar with 3D anatomy and be prepared for the analysis and interpretation of 3D images during their dental curriculum.

When participants in this study, were asked about the training of their students to assimilate the concept of the CBCT, only 11.9% responded favorably. This result, however, was comparable with that obtained in the United States [5] which has raised a rate of 18% and that recorded in Australia [5] with a rate of 29%. On the other hand, the result obtained by our study was very high compared to that obtained in England [5] which was zero.

Regarding the training of students in the interpretation of CBCT acquisitions, we found a rate of 25.4% of favorable responses, which remains low compared with the United States [5] where they obtained a rate of 48%, also with England [5] with a rate of 33% and Australia [5] where 57% answered yes, which allows these students to identify normal images on the CBCT and to differentiate them from pathological images.

The major indication of the CBCT was the pre-implant investigation. However, none of our participants reported training students to use implant planning software. In contrast, in the United States [5], they found a rate of 32% favorable responses, 29% in Australia [5], and only 7% in England [5].

For residents, 18.6% of our participants reported training their future medical specialists to assimilate the CBCT concept. This rate remains low compared to the United States [5] (43%) and Australia [5] (29%). However, this result was very high comparing it with England [5] where they raised a rate of only 7%. The same result (18.6%) was found in the question concerning the training of residents in the interpretation of CBCT acquisitions. This rate was considered very low compared to the United States [5] with a rate of 81%, with England [5] (53%), and also with Australia [5] where they obtained a rate of 57% of favorable responses.

In the study conducted in USA and Canada [6] which interested only orthodontic residents, they found that 14.3% of West Region residents were responsible for interpreting CBCT. While in the Eastern region, 67% of CBCT were sent directly to a radiologist for their interpretations.

In this same study, they found a rate of 18.2% concerning the use of the CBCT as a means of diagnosis in all patients. The remaining 81.8% who had access to a CBCT but did not use it in the diagnosis of each patient, have declared using it only in the diagnosis of complicated cases such as the presence of a facial abnormality, a supernumerary tooth.
This study [6] also found that 59.1% of residents receive theoretical and practical training on the CBCT, while 39.8% receive only theoretical training.

As for the study conducted by Whitesides et al., (2015), they found that 45% of residents of oral and maxillofacial surgery department received theoretical training on the CBCT, while only 24% receive only practical training [7]. But regarding the training of dental residents in the application of an implant planning software, all our participants answered no. In contrast, in the United States [5], they achieved a very high score of 58%, also in England [5] with a result of 40% and in Australia [5] with a rate of 57%. So we notice that in these countries, dental residents were more involved in 3D training regarding the acquisition of images, their interpretations and also in the use of implant planning software.
In addition, in the study that concerned orthodontics' residents [6], the manipulation of the CBCT was one of the responsibilities of the resident with a rate of 13.6%, the technician with a rate of 54, 5%, and the resident in collaboration with the technician in 31.8%. According to Abdelkarim (2019) there is a strong consensus amongst position statements released by international organizations regarding CBCT in orthodontics, stating that CBCT is justified only when it brings a benefit to the patient or changes the outcome of the orthodontic treatment when compared with

conventional imaging techniques [9]. Regarding the frequency of prescription of the CBCT, 15.5% of our participants answered by often, 70.7% answered sometimes and 13.8% answered by never.

The pre-implant assessment has been judged to be the most frequently used case of the CBCT, followed by other clinical situations such as the presence of tumor pathology to see the limits of the tumor and its relationship with the bone tables, dental inclusion, presence of extensive periapical lesion with failure of endodontic treatment, evaluation of the ratio of the third molar with the mandibular canal or with the sinus, preparation for orthognathic surgery, perforations or root resorptions, presence of supernumerary teeth.

However, if our participants did not prescribe the CBCT for all the patients, it was because of its high cost in 63.6% of cases, the unavailability of the apparatus in 18.2% of cases or that they considered that the examination was useless in 9.1% of cases. In the United States, Whitesides et al., (2015) also noted that the major use of the CBCT was for dental implants (75%). But 5% of the participants in their study said they did not use this exam in any of their implant cases [7].

We hypothesized that there would be a relationship between the involvement of the CBCT teaching in dentistry and the practice sites of our doctors and the dental specialty that they practice. This work allowed us to check it. Indeed, doctors practicing in Rabat were more likely to report offering training courses to assimilate the concept of CBCT to their students than those practicing in Casablanca. This difference between exercise sites was no longer significant when it comes to presenting this type of training to residents of both faculties. However, surgical odontology had the highest rate in term of training both students and residents in assimilating the concept of the CBCT. This result seems logical, since the department of surgical odontology is the most implicated in implant placement which represents the major indication of prescription of the CBCT to the patients, as well as the large oral surgeries notably the exercise of the tumors and cysts. In the United States, Whitesides et al., (2015) had shown through their study that 83% of residents in oral and maxillofacial surgery department were trained during their studies to assimilate the concept of the CBCT [7]. Among orthodontic residents in the United States, Smith et al., (2011) reported a theoretical and practical training rate of 59.1%, while 31.8% received only theoretical training on the CBCT [6]. In addition, they found that 18.2% of orthodontic residents prescribe CBCT for the diagnosis of all patients. The remaining 81.8% prescribed it only in the diagnosis of specific clinical cases such as the presence of supernumerary teeth, in case of facial abnormality [6].

With respect to training in the interpretation of CBCT acquisitions, no significant differences were found among students in different practice site. On the other hand, the results of the study showed that residents in Rabat were better trained to interpret CBCT (36.8%) than those in Casablanca (10.0%).

For the dentistry disciplines, surgical odontology still had the highest rate (66.7%) in student training in the interpretation of CBCT acquisitions. This difference among specialties becomes insignificant regarding the training of dental residents. In the same study carried out in the United States, Australia and England, they did not establish any relation between the teaching of the CBCT and the practice sites nor the odontological specialty of the participants [5].

Based on the report of the International Congress of Oral Implantology [10], CBCT prescribing practitioners must be competent in the interpretation and analysis of the entire image volume, as fortuitous discoveries can be omitted in cases of incompetence. These may include bone or sinus pathology, intracranial or vascular calcifications, or asymmetry of the airways. Thus the clinician may be considered to be responsible for an incomplete diagnosis, even if it was not part of his area of practice. In the study carried out by Jacobs et al., (2018) dental CBCT could be justified for presurgical diagnosis, preoperative planning and peroperative transfer for oral implant rehabilitation, whilst striving for optimization of CBCT based machine-dependent, patient-specific and indication-oriented variables [11].

In this study, surgical odontology had the highest rate in CBCT prescription (66.7%). This confirms that the pre-implant check-up represents the major indication of prescription of CBCT.

In contrast, the periodontics department had the highest rate among specialties that never prescribe CBCT to their patients (20%). In the study, conducted by Yang et al., (2019), on CBCT performance to measure the periodontal bone loss, their conclusion was that the results of CBCT do not agree with results of intra-surgical measurement [12]. As a result, CBCT should be used with caution and only when necessary, to avoid radiation hazards. And in systematic review carried out by Walter et al., (2016) on the CBCT use in diagnosis and treatment planning in periodontology, the CBCT may improve diagnostic accuracy and optimize treatment planning in periodontal defects, particularly in maxillary molars with furcation involvement, and that the higher irradiation doses and cost-benefit ratio should be carefully analyzed before using CBCT for periodontal diagnosis and treatment planning [13].

In their study Buchanan et al., (2017) found that, few (12.4%) of participants had experience with CBCT in dental school and that their interest in continuing dental education on CBCT was reported at 59.8% [8]. In study conducted in India [14], it was concluded that the students' should be provided with thorough practical knowledge. Similar conclusions were obtained from the study in Turkey [15] that efforts should be made to improve students' knowledge base regarding CBCT and that the dental school curriculum should devote more curriculum time to this promising new technology. In study evaluating the the educational status of CBCT in U.S. dental schools [16]. This study concluded that it is the responsibility

of dental educators to incorporate the most updated information on this technology into their curricula in a timely manner, so that the next generation of oral health providers and educators will be competent in utilizing this technology for the best interest of patients. In Morocco, however, data has shown that educational experiences in technology and CBCT interpretation were not as widespread as they should be, given the growing importance of this imaging system in many practices of dental specialties. Inclusion of CBCT imaging in dental education is essential to prepare graduating dental students to perform treatment planning utilizing 3D images to improve the accuracy and reliability of dental treatment planning and outcomes.

5. CONCLUSION

CBCT is undeniably well established as a reference technique in dental and maxillofacial imaging. For a long time, we have been waiting for a tool specifically adapted to the study of the face and teeth, performing and not very radiating. The CBCT technique meets this need.

Implantology remains the flagship discipline of indications for the CBCT. The latter provides a real help to pre-implant diagnosis, making possible to obtain measurements on the height and thickness of the bone, giving information on the various anatomical obstacles both at the maxillary and at the mandibular level, facilitating thus the surgical approach.
The big progress of imaging has led to the development of implant planning software. The CBCT has the advantage of more easily processing the images collected with this software dedicated to implantology; computer-assisted implant planning becomes easier.

From this study, we observed that the incorporation of CBCT teaching courses in dental faculties in Morocco remains low, hence the need to reflect on strategies to increase the interest of dental school teachers in CBCT so that the laureates of these schools will be able to use this type of examination in daily practice and above all for good purpose.

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