

Clinical utility of Cone Beam Computed Tomography to define treatment in cases of medium and high endodontic complexity.

Utilidad clínica de la Tomografía computarizada cone beam para definir conducta terapéutica en casos de mediana y alta complejidad endodóntica.

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Abstract: The aim of this study was to evaluate the clinical utility of Cone Beam Computed Tomography (CBCT) in cases of medium and high endodontic complexity. The relevance of CBCT to define treatment was evaluated through the Wittenberg questionnaire and the variation in treatment plans after CBCT exam analysis. The sample (n=40) was chosen for convenience over a period of 4 months. It considered the current recommendations to request CBCT exams before performing root canal treatments. Data collection was carried out through a survey applied to the treating clinicians, after examining the information obtained by the CBCT system. Data were analyzed with the Stata version 13 software, and the Chi-square test was used for inferential analysis. A 95% confidence interval was considered. The most frequent dental groups corresponded to upper posterior and upper anterior teeth (47.5% and 30.0%); the cases were equally distributed according to complexity (50% and 50%). The main reason for requesting CBCT exams corresponded to complex anatomy and/or atypical canal system (37.5%). The use of CBCT increased confidence in the initial treatment chosen by clinicians in 50% of cases according to the Wittenberg questionnaire, and a 45% variation in treatment plans was observed. There was no statistical relationship between complexity and the variables studied. CBCT contributed greatly to the therapeutic management of cases regardless of their complexity.

Keywords: *Cone-beam computed tomography; endodontics; decision making; root canal therapy; surveys and questionnaires; tooth root.*

Resumen: El objetivo de este estudio fue evaluar la utilidad clínica de la Tomografía Computarizada Cone Beam (CBCT) en casos de mediana y alta complejidad endodóntica. Se midió la relevancia del CBCT para definir conducta terapéutica a través del cuestionario de Wittenberg y en la variación de los planes de tratamientos posterior al análisis del examen. La muestra (n=40) se eligió por conveniencia en un período de 4 meses, considerando las recomendaciones actuales para solicitar este examen en Endodoncia. La recolección de datos se realizó por medio de una encuesta aplicada a los clínicos tratantes, después de examinar la información obtenida por el CBCT. Los datos se analizaron a través del software Stata version 13 y para el análisis inferencial se utilizó la prueba de chi cuadrado. Se utilizó un intervalo de confianza de 95%. Los grupos dentarios más frecuentes correspondieron a posteriores y anteriores superiores (47,5% y 30,0%), los casos se distribuyeron igualmente según complejidad (50% y 50%), el motivo principal para solicitar el CBCT, correspondió a anatomía del sistema de conductos de carácter complejo y/o atípico (37,5%), el CBCT aumentó la confianza en el tratamiento inicial escogido por los clínicos en el 50% de los casos según el cuestionario de Wittenberg y se obtuvo un 45% de variación en los planes de tratamientos. No se apreció relación estadística entre la complejidad con las variables estudiadas. El CBCT aportó en gran medida el manejo terapéutico de los casos independiente de su complejidad.

Palabras Clave: *Tomografía computarizada de haz cónico; endodoncia; toma de decisiones; tratamiento del conducto radicular; encuestas y cuestionarios; raíz del diente.*

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INTRODUCTION.

Cone-Beam Computed Tomography (CBCT) is used in root canal treatment to analyze complex cases, due to its capacity to produce a highly-detailed three-dimensional image that is significantly superior to conventional intraoral radiographic technique.¹ However, the extent to which it would be advisable to request a CBCT exam is not clearly defined, particularly considering the diversity of clinical situations, and the difficulty of conducting *in vivo* studies in patients who will undergo radiation. Moreover, until now, most of the research evaluating CBCT in clinical practice has focused on case reports or case series with small study samples.²⁻⁴

In 2012 the European Commission on Radiation Protection published clinical guidelines for the use of CBCT in dental practice. This document was created by the SEDENTEXCT project, a multidisciplinary group consisting of specialists from various areas such as dentistry, radiology, and radiological industry technicians.⁵ The American Association of Endodontists (AAE) also published a joint statement with the American Academy of Oral and Maxillofacial Radiology containing indications for CBCT applications in root canal therapy. The latest consensus on this matter will be updated as new evidence becomes available.⁶ (Table 1)

Although both guidelines have differences in their recommendations for the use of CBCT, the importance of producing more research was pointed out. The aim is to determine the usefulness of this exam in those clinical situations that have not been described in depth in the literature and that have not been included in the current recommendations.^{5,6}

In a study conducted by Mota *et al.*,⁷ the clinical utility of the CBCT was evaluated in cases where the exam was requested following the recommendations of the European Commission. The publication showed that CBCT increased the confidence of the clinician until the point of drastically changing the initial treatment plan in 89% of the cases according to the Wittenberg questionnaire adapted for the CBCT study. The questionnaire was designed by Wittenberg *et al.*,⁸ during the first studies on medical tomography and it consists of two parts, both with five options of answers using an ordinal scale. The first questionnaire aims to measure the clinical

utility of medical tomography during diagnosis, and the second part, to determine the effect of the exam on the therapeutic management plan. The questionnaire was used in 2003 to evaluate positron-emission tomography (PET) in 164 patients with suspected lung cancer.⁹

It should be noted that, to date, no *in vivo* study has been carried out, including the recommendations proposed by the AAE in 2015, which established new indications for the use of the CBCT with respect to those already included by the European Commission. The aim of this study was to evaluate the clinical utility of CBCT in the planning of endodontic treatments according to the two current clinical guidelines.

MATERIALS AND METHODS.

An *in vivo* study was performed. The universe corresponded to the total number of patients treated at the Postgraduate Endodontics Clinic at Universidad Andres Bello, Viña del Mar, during a period of four months. Sample selection was for convenience and performed by the 12 specialty interns, following the inclusion and exclusion criteria. In the event that a patient had more than one tooth that met the criteria, only the tooth that required more immediate treatment was included either by symptomatology, indication by another specialist, or another reason. Clinical cases were classified as medium and high complexity, considering the current recommendations. Complex cases corresponded to those described in both clinical guidelines.

In general, they correspond to situations addressed more commonly in the literature, so there is more evidence to justify the request for the CBCT exam, such as complex anatomy and/or atypical canal system, surgical procedures, resorptive lesions, and endoperiodontal lesions. For cases of medium complexity, the AAE suggests CBCT as the exam of choice; however, the same scenarios are not included by the European Commission or its use is limited to only more specific cases, such as teeth with endodontic treatments where the disease persists without apparent cause, to evaluate presence of broken off instruments, or to assess the localization of perforations.

The study sample was chosen following these inclusion criteria: patients with endodontic pathology (signs and symptoms) that required endodontic treatment or retre-

atment, and patients who presented an endodontic case considered of medium or high complexity.

On the other hand, cases were ruled out following these exclusion criteria: patients who had a dental pathology that prevented the correct treatment and when exodoncy had already been indicated, patients who had undergone a previous tomographic study of the area, subjects with any uncontrolled systemic disease, and uncooperative patients. The exam was carried out at the School of Dentistry at Universidad Andres Bello, Viña del Mar, Chile.

The tomographic equipment was a Gendex GXCB-500, an 8.5cm wide window with a variable height range was used. The size of the Voxel was 0.200mm, and it worked at 120Kvp and 5mA. The imaging diagnosis was in charge of a specialist in Oral and Maxillofacial Imaging, currently working at School of Dentistry of Universidad Andrés Bello. Consequently, the treating clinicians had the possibility to discuss directly with the specialist the radiological findings obtained through the I-Cat software.

Data were recorded by the clinicians, through a survey, which collected the variables age, sex, tooth, complexity, reason to indicate CBCT, initial treatment plan, final treatment plan, and Wittenberg questionnaire adapted by Mota *et al.*,⁷ for the CBCT study (Figure 1). Clinicians answered the survey, once the therapeutic approach was defined, after analyzing the results of the exam. The choice of initial and final treatment plans corresponded to: no treatment, further check-up, conventional endodontic treatment, microsurgery, extraction, or other.

The clinical utility of the CBCT was evaluated through the Wittenberg questionnaire and through the variation between the initial and final treatment plans. For data analysis, a 95% confidence interval was estimated.

Descriptive statistics were performed using frequency tables and graphs. On the other hand, the inferential analysis was carried out by Pearson's Chi-square test, to estimate the statistical relationship between the variation in treatment plans according to dental group and complexity using the Stata Software version 13.

Each patient was asked to sign an informed consent form to participate in the study. Confidentiality of personal data was kept all the time. This research was approved by the Research and Ethics Committee of Universidad Andres Bello, Viña del Mar, on July 18th, 2018.

RESULTS.

The total examined sample consisted of 40 patients, with a mean of 41 years of age. Twenty-eight cases corresponded to females and 22 to males. CBCT was requested more frequently for the study of the upper posterior teeth accounting for 47.5%; upper anterior teeth accounted for 30%. Regarding complexity, 20 cases were of median complexity, and 20 cases of high complexity.

The reasons for requesting the CBCT exam mainly corresponded to: complex anatomy and/or atypical canal system (37.5%), and teeth with endodontic treatments where the disease persisted, in order to determine the therapeutic approach (22.5%). (Figure 2)

Options 3 and 5 accounted for 95% of the Wittenberg questionnaire responses. (Table 2)

After CBCT analysis, 45% variation in treatment plans was obtained. No statistical relationship was observed between the variation in treatment plans and the complexity variable (p -value: 1.000). (Table 3)

Similarly, no statistically significant relationship was found between the variation of treatment plans and dental group (p -value: 0.069). (Table 4)

Figure 1. Adapted version of Wittenberg questionnaire used in the study.

Wittenberg Questionnaire

According to the data provided by the CBCT exam and its contribution to define the therapeutic approach, you think that (please choose one option):

- 1) Studying the case retrospectively, the CBCT exam did not benefit the patient.
- 2) The initial treatment plan did not change after CBCT analysis.
- 3) The treatment plan did not change, but the CBCT exam increased my confidence in the chosen therapy.
- 4) The CBCT exam helped to **change the initial treatment plan**, but other factors such as _____ had a greater impact.
- 5) Compared to other factors, the CBCT exam was very important to change the initial treatment plan.

Figure 2. Reasons to perform CBCT exams according to dental group.

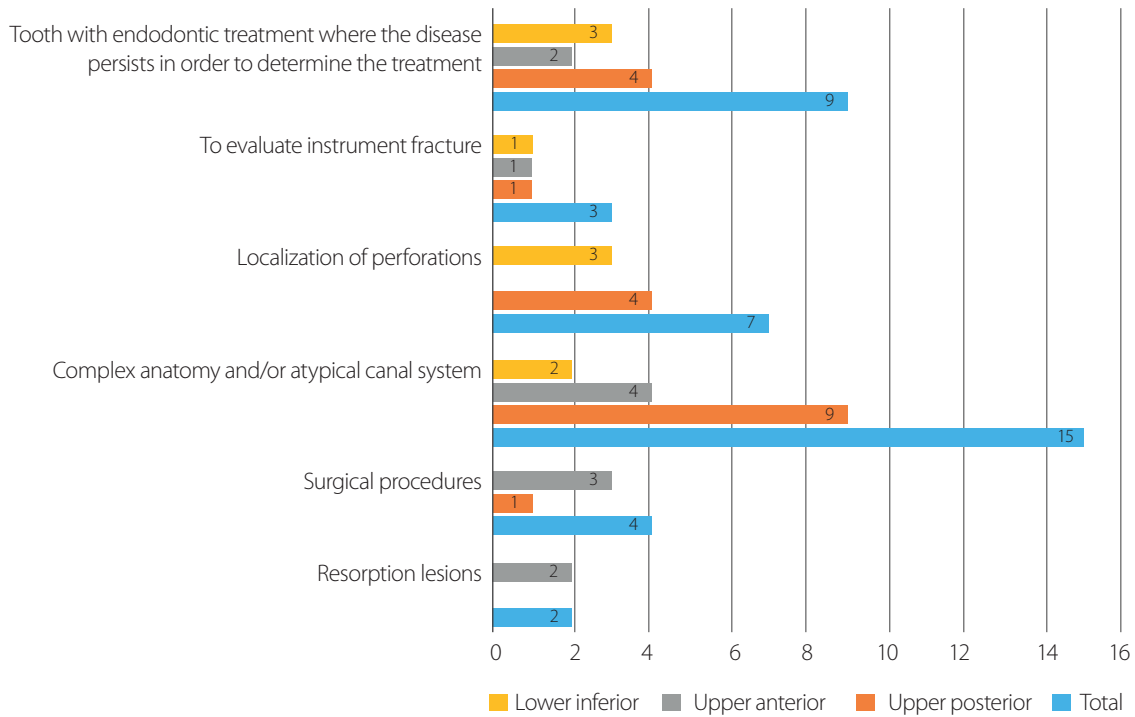
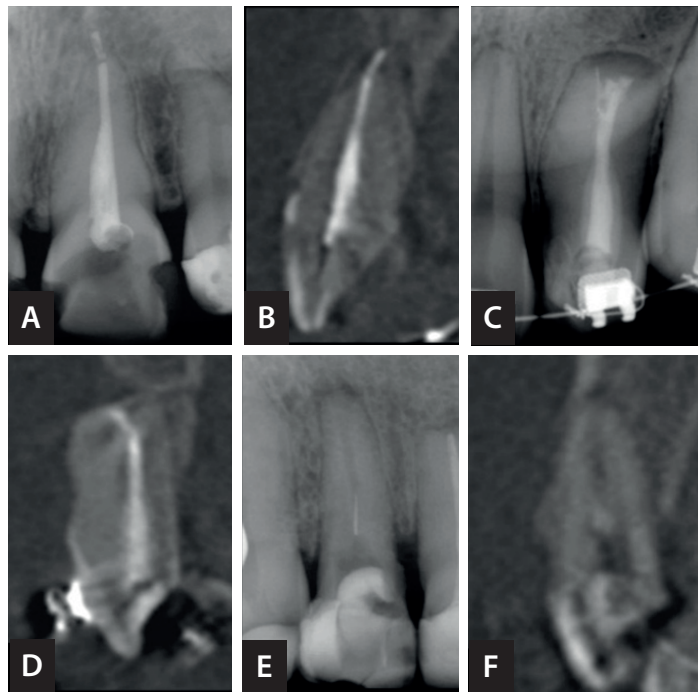


Figure 3. Example of upper anterior teeth included in the study.



- A: Periapical X-ray of tooth 2.1. Apical surgery was initially indicated, but after analyzing the CBCT exam.
- B: It was decided to perform the extraction due to the poor rehabilitative prognosis (option 5 of Wittenberg questionnaire).
- C: Tooth 2.2 with atypical anatomy previously treated with apical surgery. In this case, CBCT was requested as a checkup exam to evaluate the evolution of the osteolytic lesion after 6 months. When analyzing the CBCT.
- D: It was decided to maintain the initial treatment that consisted of a further checkup (option 3 of Wittenberg questionnaire).
- E: Periapical X-ray of tooth 1.2. Fragment of endodontic instruments is observed in the middle third of the root. The CBCT exam.
- F: Did not change the treatment plan, but it helped to improve the clinician's confidence in the treatment plan (option 3 of the Wittenberg questionnaire).

Table 1. Summary of current recommendations for requesting a CBCT exam during endodontic treatment.

European Commission 2012	AAE 2015
The use of a high resolution small field of view CBCT may be indicated for specific cases in the following clinical situations:	The use of the small field of view CBCT should be considered as the image of choice in cases of:
When intraoral radiography delivers inadequate information of the root canal system for treatment planning.	Teeth with contradictory or non-specific clinical signs.
Planning of surgical endodontic procedures.	Teeth that can potentially present extra canals.
In select cases of inflammatory root resorption.	Teeth with endodontic treatment when the disease persists.
Specific cases considered complex due to the following factors: resorption lesions, endo-periodontal lesions, perforations and atypical pulp anatomy.	Vertical fractures in cases where intraoral radiography provides non-conclusive information.
Endodontically treated teeth that show no signs of healing or recovery.	Evaluation of previous complications such as overfilling, separated endodontic instruments, and localization of perforations.
	Planning of periapical surgery.
	Root reabsorption.
	Dentoalveolar trauma.
	Other specific conditions.

Table 2. Results of Wittenberg questionnaire.

Wittenberg Questionnaire (1 – 5)	Frequency (n)	%
1) Studying the case retrospectively, the exam did not benefit the patient.	0	0.0
2) The initial treatment plan did not change.	1	2.5
3) The treatment plan did not change, but it increased my confidence in the chosen therapy.	20	50
4) It helped to change the initial treatment plan but other factors had a greater impact.	1	2.5
5) Compared to other factors, it was very important to change the initial treatment plan.	18	45
Total	40	100

Table 3. Variation in treatment plans after CBCT exam analysis according to complexity. There is no statistically significant relationship between both variables (*p*-value: 0.728).

Complexity	Variation in the treatment plan					
	No		Yes		Total	
	n	%	n	%	n	%
Medium	11	27.5	8	20	19	47.5
High	11	27.5	10	25	21	52.5
Total	22	55.0	18	45	40	100

Table 4. Variation in treatment plans after CBCT exam analysis according to dental group. There is no statistically significant relationship between both variables (*p*-value: 0.069).

Variation of treatment after CBCT	Dental group							
	Upper posterior (n)	%	Upper anterior	%	Lower posterior(n)	%	Total	%
No	14	35.0	4	10	4	10.0	22	55
Yes	5	12.5	8	20	5	12.5	18	45
Total	19	47.5	12	30	9	22.5	40	100

DISCUSSION.

The present study is the first to apply the two current recommendations for CBCT application in endodontics in a sample of 40 cases.

Most of the studies evaluating the application of CBCT in clinical practice have been carried out in smaller samples or by applying one of the two clinical guidelines.^{2-4,7}

Mota *et al.*,⁷ used a sample of 53 patients; their study presents the greatest methodological similarity to the present research. In their study, the dental groups examined by CBCT most frequently corresponded to upper posterior (49%), followed by upper anterior (22%). In this study the results for upper posterior and upper anterior were 47.5% and 30%, respectively. (Table 4)

This indicates that both dental groups would present common characteristics observable in the samples of both countries (Sweden and Chile), and that it would be possible to extrapolate the results to other populations.

The reason why the clinicians mostly requested CBCT of the upper posterior teeth is due to the high degree of overprojection generated by the teeth in this anatomical area on the radiographic film, which usually produces images that are difficult to interpret on a periapical radiograph when trying to identify accessory canals, or to differentiate pathology from normal anatomy, among other difficulties.^{10,11}

There is probably some prejudice in dental practice when considering the group of upper anterior teeth as cases of low complexity. It was possible to observe factors that determined the need for retreatments and apical surgeries for this dental group, along with the presence of atypical anatomy that could lead to technical errors during endodontic treatment. (Figure 2)

Figure 3 shows upper anterior teeth included in the study. These results are consistent with a 2017 study where apical lesions and technical errors were found more frequently in: upper molars (56%), followed by upper anterior teeth (38%) in a total of 1146 previously treated canals.¹² No statistically significant relationship between dental group and variation in treatment plans (p -value 0.069) was obtained. In this way CBCT would have a similar clinical utility to define the therapeutic approach independent of the dental group. (Table 4)

When comparing the variation in treatment plans

(45%), according to complexity, there was no statistically significant relationship between these variables (p -value 1.000). That is, the CBCT exam was a tool that helped define therapeutic approach in a significant number of cases independent of their classification according to degree of complexity. These findings can be compared with the data obtained by Mota *et al.*,⁷ who reported similar results to the questionnaire without including the cases that were considered of medium complexity in this study. As such, in the study by Mota *et al.*,⁷ as well as in the present research, CBCT contributed to the therapeutic management of cases through, mainly, increasing the confidence in the treatment chosen by clinicians, followed by the change or variation in treatment plans. (Table 2).

In a study carried out by Rodríguez *et al.*,¹³ CBCT changed treatment plans in 27.3% of the cases according to the AAE indications. This result, although lower than the one obtained in the present research and the one described by Mota *et al.*,⁷ increased to 52.9% when the cases were considered of high complexity according to the criteria of the observers. Rodríguez *et al.*,¹³ propose that a preoperative CBCT study is recommended in cases described by the AAE independent of the level of difficulty, taking into account that CBCT improves the level of understanding of each case.

No cases of endoperiodontal lesions, and lower anterior teeth were observed. With respect to the Wittenberg questionnaire, there were no cases categorized in the first alternative of the questionnaire. This could have been avoided with a larger sample that would provide greater variability in the distribution of the data.

A study conducted in Europe indicates that 46% of specialists never or hardly ever request CBCT exams as a preoperative examination in cases of high complexity.¹⁴ Consequently, it can be assumed that according to the results of the present study, endodontic practice and therapeutic decisions would be poorly handled in a significant percentage for not having requested a CBCT study. It is also mentioned that the frequency of CBCT exams depends on the access to tomographic equipment more than any other variables, such as the type of certification of the specialist or the years of experience in the specialty.^{14,15}

The present study did not cover cases that could be

considered of “low complexity” because they do not agree with current consensus and, in general, the evidence does not support the request of a CBCT exam in patients who probably do not require it after analyzing the conventional radiography.¹⁶ However, considering the high contribution of CBCT in this study, it is interesting to wonder what would the effect of CBCT be in those cases where the exam is not usually indicated. Currently, it is mentioned that CBCT has the potential to become the image of choice in the future as new equipment capable of emitting a lower effective dose is developed. When this occurs, technical errors made today may be avoided considering the high specificity and sensitivity of CBCT for imaging diagnosis.¹⁷⁻¹⁹

CONCLUSION.

CBCT contributed significantly to the therapeutic management of cases, regardless of complexity or dental group. The main utility of CBCT was increasing the confidence of the clinicians in the initial treatment plans (50%), followed by the drastic change or variation in the therapeutic approach adopted prior to CBCT (45%).

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