86053.docx

WORD COUNT	4919	TIME SUBMITTED	30-JUN-2023 02:56PM
		PAPER ID	100900350

Name of Journal: *World Journal of Clinical Cases*
Manuscript NO: 86053
Manuscript Type: ORIGINAL ARTICLE

Retrospective Study

Comparison of five-year outcomes of immediate implant placement for mandibular molars with chronic apical periodontitis and those without obvious inflammation: a retrospective study

Immediate implant placement for mandibular molars with chronic apical periodontitis

Hua Yang, Dan Luo, Mu-Jie Yuan, Jian-Jun Yang, Da-Shan Wang

Abstract

BACKGROUND

Most physicians consider molars with chronic apical periodontitis (CAP) lesions as contraindications for immediate implant placement. At the request of the patient, we tried to immediate implant placement of mandibular molars with CAP in clinical work.

AIM

The aim of this study was to retrospectively analyze and compare the 5-year outcomes of immediate implant placement of mandibular molars with CAP and those without obvious inflammation.

METHODS

The clinical data of patients with immediate implant placement of mandibular molars in the Department of Oral and Maxillofacial Surgery, the Affiliated Hospital of Qingdao University from June 2015 to June 2017 were collected. The patients were divided into CAP group (n = 52) and No-CAP group (n = 45). The changes of bone mineral density and bone mass around implants were analyzed 5 years after implant restoration.

RESULTS

At 5 years after implantation, the peri-implant bone mineral density was 528.2 ± 78.8 Hounsfield (HU) in the CAP group and 562.6 ± 82.9 HU in the No-CAP group (P = 0.126). There was no statistically significant difference in marginal bone resorption around implants between the two groups, including buccal (P = 0.268) and lingual (P = 0.526) in the vertical direction and buccal (P = 0.428) and lingual (P = 0.560) in the horizontal direction. There was no statistically significant difference in the changes in the peri-implant jump space between the two groups, including the buccal (P = 0.247) and lingual (P = 0.604) in the vertical direction and the buccal (P = 0.527) and lingual (P = 0.707) in the horizontal direction. The gray value of Cone-beam computed tomography measured by Image J software can reflect the bone mineral density. In the CAP area, the gray values

of the bone tissue immediately and 5 years after implant placement differed significantly from those of the surrounding bone tissue ($P < 0.01$).

CONCLUSION

The results of this study suggest that immediate implant placement of the mandibular molars with CAP can achieve satisfactory 5-year clinical results, without significant differences in the complications, survival rate, or bone tissue condition from No-CAP mandibular molars.

Key Words: Molar; Chronic apical periodontitis; Dental implantation; Bone density; Treatment outcome; Retrospective study

Yang H, Luo D, Yuan MJ, Yang JJ, Wang DS. Comparison of five-year outcomes of immediate implant placement for mandibular molars with chronic apical periodontitis and those without obvious inflammation: a retrospective study. *World J Clin Cases* 2023; In press

Core Tip: This study was to retrospectively analyze and compare the 5-year outcomes of immediate implant placement of mandibular molars with chronic apical periodontitis and those without obvious inflammation by the changes of bone mineral density and bone mass around implants were analyzed 5 years after implant restoration.

INTRODUCTION

Chronic apical periodontitis (CAP) is a globally prevalent infectious disease, characterized by the inflammatory response of periapical tissues and local alveolar bone destruction caused by intramedullary microbial infection[1,2]. Compared to other bones in the body, the alveolar bone can communicate directly with the outside environment through the dental pulp; if the pulp is necrotic and infected, no epithelial barrier exists to resist infection or inflammatory factors[3]. In the development of CAP, microbial infection

and immune defense response jointly lead to local alveolar bone destruction[4-6]. Root canal therapy is the main treatment for CAP. However, after root canal treatment, CAP may persist as asymptomatic inflammation[7]. Persistent CAP after root canal treatment may be caused by failure to strictly follow the principle of asepsis, a poor approach design, residual accessory canals, improper use of instruments, incomplete debridement, and microleakage of the temporary or permanent prosthesis[8].

Due to the complexity of the main and accessory root canal systems and residual infection at the root canal branches and anastomosis, the mandibular molars may develop persistent CAP even after following the most stringent root canal treatment procedures, resulting in persistent destruction of the periapical bone[1,2,9]. When the periapical shadow area of the affected tooth is enlarged in the periapical radiograph, the root canal retreatment is difficult to perform, and the affected tooth cannot be retained, the method of restoring the affected tooth after extraction should be considered[10].

Since Branemark successfully implanted the first dental implant in 1965, the dental implant technology has been an effective method to restore the masticatory and esthetic functions of the dentition for patients with missing teeth[11,12]. The initial treatment protocol involves implant placement in the healed extraction socket, referring to the alveolar bone after healing for at least 5–6 mo after extraction of the affected tooth, a delayed dental implant. In 1989, Lazzara *et al*[13] introduced implants placed immediately after tooth extraction. In recent years, many studies have confirmed the reliability of implants placed during tooth extraction[14]. With advancements in the implant technology, immediate implant placement has become the first choice to restore missing teeth in clinical practice[15-17]. Hansson and Ekestubbe[18] and Ericsson *et al*[19] found that immediate dental implant surgery is minimally invasive, which reduces the risk of osteonecrosis and promotes the process of bone remodeling, shortening the healing period of the alveolar bone and promoting the transformation of woven bone into lamellar bone. Compared to delayed dental implant placement, immediate implant placement has advantages of shortening the treatment course, reducing the procedural pain of patients, and reducing the alveolar bone absorption in the surgical area[20].

Currently, immediate implant placement is mainly used in the anterior esthetic area in clinical practice[21].

Most molars cannot be retained after severe CAP. The complex shape of the extraction socket after extraction of the affected teeth, severe destruction of the periodontal soft tissue and alveolar bone, and presence of abundant inflammatory granulation tissue adversely affect the success rate of immediate implant placement[22]. In a prospective study, Alsaadi *et al*[23] found that immediate implant placement in teeth with CAP lesions resulted in a greater rate of implant failure compared to delayed implant placement. In addition, the retrograde peri-implantitis that occurred in the study was thought to be caused by immediate implant placement at the CAP tooth position[24]. Most physicians consider the molars with severe CAP as a contraindication for immediate implant placement. However, in recent years, data from animal studies, case reports, and prospective studies have shown that the success rate of implant placement in the teeth with CAP is similar to that in the teeth without CAP[25,26].

The aim of this study was to retrospectively analyze and compare the 5-year outcomes of immediate implant placement of mandibular molars with CAP and those without obvious inflammation by quantitative study of peri-implant bone mass changes using Simplant software and Image J software.

MATERIALS AND METHODS

Patient screening

Clinical cases of the molars that could not be retained or received immediate implant placement were collected from the Oral and Maxillofacial Surgery Department of the Affiliated Hospital of Qingdao University from June 2015 to June 2017. Figure 1 shows the patients' screening process.

This study was conducted in accordance with Declaration of Helsinki guidelines and regulations, and all study methods were approved by the Ethics Committee of the Affiliated Hospital of Qingdao University (QYFYKYLL958311920). Informed consent was obtained and signed by all participants and their families in this study.

Preoperative preparation

Inclusion criteria were: age ≥ 18 years; no pregnancy or lactation; no systemic disease and the use of related drugs; good oral hygiene with no acute inflammation in the dentition; no retentive value of the affected teeth in the posterior mandibular region as confirmed by oral physicians and prosthodontists (Figure 2 A-C); patient consent for immediate implant placement; and willingness to attend regular follow-ups. The same chief physician with 25 years of work experience completed the implant placement surgery and crown restoration, under assistance by doctors with more than 5 years of clinical experience.

Surgical procedure

All study participants underwent routine disinfection and draping in the intraoral and maxillofacial regions. We used 1% iodophor for disinfection and asked the patient to gargle for 20 s before sterilizing the maxillofacial area, up to the palpebral fissure, down to the level of the hyoid bone, and left and right to the front of the tragus. The angular mucoperiosteal flap on the buccal side of the affected tooth was completely turned over. A high-speed turbine extraction handpiece was used to extract the affected teeth by root separation to protect the integrity of the apical septum and bone wall of the alveolar fossa to the greatest extent (Figure 3 A and B). The inflammatory tissue on the edge and inside of the mucoperiosteal flap was pruned, and the inflammatory tissue attached to the inner wall of the alveolar fossa was scraped with an appropriate type of scraping spoon and scovel, and then polished with large, medium, and small ball drills until there was no fibrous tissue on the bone wall of the alveolar fossa (Figure 3C and D). The implant cavities were prepared step-wise, and the corresponding implants were selected and rotated into the implant socket using a ratchet wrench to ensure that the implants had been placed in the correct three-dimensional position, with the neck and shoulder of the implants placed 1.0–1.5 mm below the edge of the alveolar bone. The torque force after implant placement was tested using a force measuring wrench to ensure that the torque

force exceeded 35 N. cm (Figure 3E and F). The implant stability quotient was measured with the resonance frequency analyzer (Osstell, Sweden) to confirm the initial stability of the implant and install the healing abutment with appropriate diameter and penetration height. The buccal-lingual mucoperiosteal flap was tightly sutured around the healing abutment (Figure 3G). Cone-beam computed tomography (CBCT) was performed after immediate implant placement to ensure that the implants were in the correct tooth and spatial positions (Figure 2D-F).

Dental crown restoration

At 3 mo postoperatively, an impression was taken, and an all-porcelain crown was fabricated (Figure 3H and I).

Evaluation index

All patients underwent CBCT before and after the implant placement and at the follow-up visits (Figure 2). CBCT was performed by the same dental radiologist with 10 years of experience. The clinical examination and CBCT image measurement and analysis were performed by three dentists with 10, 10, and 5 years of working experience, respectively. Each dentist measured and analyzed the CBCT scans of the two groups of patients, and the results of each patient's evaluation index were averaged and recorded. The intraclass correlation coefficient (ICC) was used to test the difference of the observation results of the three observers. According to the specificity of the evaluation indicators in this study, the "peri-implant bone mineral density" with the most complicated detection steps was selected for ICC calculation, which could reflect the differences in the observation results of the three observers in this study.

(1) The bone tissue around the implant was analyzed 5 years after crown restoration. CBCT equipment and parameters were as follows: Brand model, Kava i-CAT 17-19; Tube voltage, 120 kV; Current, 5 mA; Exposure time, 26.9 s; Diameter, 16 cm; Height, 11 cm; and Resolution, 0.25 mm.

The patient sat in an upright position. The dental chair was adjusted to the appropriate height according to the patient's height. The patient's head was rested on the head support. The dentist wore protective clothing for infection control, adjusted the front center line to the center of the patient's face, directed the patient's eyes to look forward, adjusted the orbital ear plane to be parallel to the ground, and held the patient's jaw bracket. "Preview" determined that the scanning range included the patient's complete upper and lower dentition and alveolar bone, and the CBCT scan was captured.

Peripheral bone density: The CBCT scans of the CAP and No-CAP groups 5 years after dental crown restoration were exported in the Digital Imaging and Communications in Medicine format and imported into Simplant software (Materialise Dental, Belgium). The alveolar bone density was measured around the virtual implant (Figure 4 A).

Vertical and horizontal marginal bone loss: The implant long axis L0 and the implant shoulder plane L1 perpendicular to L0 were determined. In the vertical direction, the vertical distance from the crest of the buccal and lingual alveolar crests to L1 (H1) was measured. In the horizontal direction, the distance (W1) between L1 and the lateral side of the buccal and lingual bone walls and the intersection of the implant edge was measured (Figure 4 B). Each group of data was measured thrice, with an average accuracy of 0.01 mm. The buccal and lingual vertical and horizontal marginal bone loss from immediately after implant placement to 5 years after crown restoration in the CAP and No-CAP groups were calculated.

Changes in the jump gap: The long axis L0 of the implant body and the shoulder plane L1 perpendicular to L0 were determined. The vertical distance from the highest point of implant-bone contact to L1 (H2) was measured immediately after surgery and 5 years after crown restoration, and the distance between L1 and the intersections of buccal and lingual bone walls and implant edges (W2) was measured (Figure 4 B). The data in each group were measured thrice, with an average accuracy of 0.01 mm. Changes in buccal and lingual jump gaps in the CAP and No-CAP groups 5 years after crown restoration were calculated.

(2) Changes in bone density in the CAP-damaged areas

The CBCT scans of the largest area of bone destruction in the horizontal plane of the CAP group were selected and exported in the .jpg format. With the Image J software, the region of interest was selected in the image, avoiding areas such as the surrounding alveolar bone and root tip as much as possible. After determining the region of interest, the "Measure" option in the toolbar was selected, followed by the "Analyze" option to obtain the gray value of the inflammatory bone destruction area and surrounding bone tissue (Figure 4 C). Differences in the gray value between the two were calculated and recorded. The gray values of the bone destruction area and surrounding bone tissue in the same area 5 years after crown restoration were obtained with the same method, and the difference in the gray values between the two was calculated and recorded. The obtained gray value cannot directly be used as the bone mineral density value, but the difference in the gray values between the area of inflammatory bone destruction and the surrounding bone tissue immediately and 5 years after surgery can represent the change in bone mineral density in this area.

Statistical analysis

ICC calculations and statistical tests were performed using SPSS 20.0 (IBM, Chicago, IL). The age of the patients belonged to non-normal distribution data, and the Wilcoxon Signed Rank Test was used for analysis. The data of peri-implant bone tissue changes (bone mineral density, marginal bone loss, jump gap, gray value) belonged to normal distribution data and were analyzed by independent sample *t*-test. For the gender of patients, Chi-square test was used to analyze them. A P-value < 0.05 was considered to indicate statistical significance.

RESULTS

We enrolled 97 teeth of 97 patients, with 52 patients in the CAP group, including 28 women and 24 men, aged 35.6 ± 5.28 (68-18) years, and 45 patients in the No-CAP group, including 19 women and 26 men, aged 36.8 ± 4.79 (66-20) years. Patient age (P = 0.385) and sex (P = 0.314) distribution did not differ significantly between the two groups

(Tables 1 and 2). The "peri-implant bone mineral density values" measured by three observers in this study were tested for inter-observer difference, and the calculated ICC value was 0.816, which was between 0.75 and 0.9, indicating a good consistency of the observation results[27].

Implant repair complications and retention

The clinical records of the two groups within 5 years were analyzed. In the CAP group, one patient developed central screw loosening, and one patient experienced restoration chipping. In the No-CAP group, one patient's prosthesis fell off, and one patient's prosthesis chipped off. After the corresponding treatment, the implant condition was good. The implants in the two groups were in position and functioned well, and the survival rate was 100%.

Changes in bone tissue around the implant

The CBCT data were imported into Simplant software to measure and compare changes in bone mineral density of peri-implant bone tissue after 5 years of implant denture restoration. The peri-implant bone densities were 528.2 ± 78.8 Hounsfield (HU) and 562.6 ± 82.9 HU after 5 years of implant restoration in the CAP and No-CAP groups, respectively. The independent-samples t-test showed no significant difference in the peri-implant bone density between the two groups (P = 0.126).

Figure 5A and B shows the amount of bone resorption at the implant edge. In the vertical direction, the buccal marginal bone loss was 0.43 ± 0.16 mm in the CAP group and 0.47 ± 0.14 mm in the No-CAP group, showing no significant difference between the two groups (P = 0.268). The marginal bone loss did not differ significantly between the CAP (0.43 ± 0.14 mm) and NC (0.45 ± 0.14 mm) groups (P = 0.526). In the horizontal direction, the buccal marginal bone loss was 0.91 ± 0.22 mm in the CAP group and 0.86 ± 0.23 mm in No-CAP group, showing no significant difference between the two groups (P = 0.428). The marginal bone loss was 0.67 ± 0.15 mm in the CAP group and 0.64 ± 0.22 mm in the No-CAP group (P = 0.560), showing no significant difference.

In the vertical direction, the incremental value of the highest point of buccal implant–bone contact was 3.04 ± 1.21 mm in the CAP group and 3.36 ± 0.89 mm in the No-CAP group, showing no significant difference (P = 0.247). The implant bone increment at the highest point of lingual implant–bone contact was 2.80 ± 0.78 mm in the CAP group and 2.71 ± 0.63 mm in the No-CAP group, showing no significant difference (P = 0.604; Figure 5 C). In the horizontal direction, the width change in the buccal jump gap was 3.44 ± 0.95 mm in the CAP group and 3.30 ± 0.83 mm in the No-CAP group, showing no significant difference (P = 0.527). The width change in the lingual jump gap was 2.57 ± 0.78 mm in the CAP group and 2.84 ± 0.63 mm in the No-CAP group, showing no significant difference (P = 0.707; Figure 5 D).

Changes in the bone density of the CAP-damaged area

The inflammatory bone destruction area of the alveolar bone in the CAP group disappeared 5 years after implant denture restoration. The gray value difference between the CAP lesion area and the surrounding bone tissue was 107.6 ± 21.7 immediately after surgery and 32.5 ± 15.3 5 years after implant restoration, with significant differences between the two groups (P < 0.01).

DISCUSSION

Currently, immediate implant placement is the preferred modality to restore the missing anterior teeth[28]. For the mandibular molars, immediate implant placement is often contraindicated because of the large area of CAP lesions around the root apices and severe alveolar bone destruction[29]. Therefore, delayed dental implant placement is chosen, which prolongs the restoration time of the missing teeth and aggravates pain[30]. In this retrospective study, the patients who had received immediate implant placement and crown restoration with successful outcomes after 5 years were selected. The aim of the present study was to investigate the clinical effect of immediate implant placement for the missing mandibular molars.

Osseointegration is the decisive factor for the success of implant restoration[31]. The larger the contact area between the implant surface and the trabecular bone in the surrounding alveolar bone, the better is implant osseointegration[32]. The study revealed no significant differences in bone mineral density between the chronic periapical teeth with immediate restoration and the teeth with conventional immediate restoration 5 years after immediate restoration. Microbial antigens derived from root canal infections can stimulate specific and nonspecific immune responses in periapical tissues[33]. Macrophages, mast cells, T cells, and neutrophils are involved in the formation of CAP tissue, including cytokines and chemokines[33,34]. Therefore, the inflammatory tissue in the alveolar fossa should be completely removed to reduce the influence of inflammatory factors around the implant on the bone tissue.

The marginal bone level plays a crucial role in maintaining the stability and function of implants, with great significance in the long-term survival rate of implants[35]. As for the vertical marginal bone mass, Kakar *et al*[36] found that during immediate implant placement for the teeth with CAP, the risk of residual infection can be reduced by curetting the inflammatory granulation tissue of the extraction socket and thoroughly washing it, and the vertical marginal bone resorption can be minimized. As for the horizontal marginal bone mass, Hatting *et al*[37] found that the buccal horizontal bone mass had decreased by 0.89 mm while the lingual horizontal bone mass had decreased by 0.69 mm 1 year after immediate implant placement for a molar, similar to the results of this study. Some scholars also believe that the buccal bone wall thickness may affect horizontal bone resorption in immediate implant placement[38]. We believe that the inflammatory granulation tissue around the neck of the molars with CAP should not be ignored, owing to its relevance in marginal bone resorption of implants. Intraoperatively, the inflammatory granulation tissue can be completely removed by making an incision and raising a flap to prevent the destruction of the alveolar bone in the implant socket and reduce marginal bone resorption of implants. In addition, we positioned the necked shoulder of the implant 1.0–1.5 mm below the alveolar bone margin to compensate for

vertical and marginal bone resorptions and ensure that the threads of the implant were not exposed after the marginal bone remodeling had been stabilized.

The gap between the medial wall of the alveolar bone and the implant surface is called the jump gap[17,39]. The implant may be wrapped in blood clots after placement. At 1–2 wk postoperatively, osteoblasts form new woven bone on the implant surface and a bridge with the bone wall of the alveolar socket. As the woven bone continues to mineralize, it can transform into lamellar bone[39]. The present study involved no bone grafting in the jumping gap in the CAP or No-CAP group. The jumping gap healed naturally after the operation. Five years after implant placement and loading, CBCT showed that the original jumping gap had disappeared.

Bone mass loss is a clinical feature of CAP caused by microbial factors and immune defense responses[40]. As a chronic inflammatory disease, CAP causes an imbalance between bone resorption and remodeling, which leads to bone mass loss[29]. Bone resorption and formation are antagonistic and coupled processes of osteoblasts and osteoclasts, which together constitute the normal bone mass[41]. Several factors affect periapical bone remodeling, including microbes, human signaling pathways, and the immune system[42]. CAP may directly be caused by bacterial infection and trigger an immune response from the host, resulting in destruction of periapical tissues[41,43]. In the progression of pulpitis, the flora is simple in the early stage, but with the dominance of gram-negative anaerobic bacteria, such as Porphyromonas, the complexity of root canal flora increases[43]. Of all bacterial species, 54.6% are strictly anaerobic, while anaerobic gram-negative bacteria dominate the root canals with periapical lesions[44]. In the periapical infected tissues, bacterial abundance and diversity are significantly reduced, and the microbial balance in the biofilm is disrupted[45]. Endotoxin in the cell wall of gram-negative bacteria can cause local tissue swelling and bone resorption and mobilize the host immune response. Further, its content is positively correlated with the degree of bone injury[46]. It can promote osteoclast differentiation and bone resorption induced by lipoic acid and participate in maintaining the survival of mature osteoclasts, thereby jointly causing inflammatory alveolar bone loss[46].

Therefore, in the immediate implant surgery in the present study, we should removed the inflammatory tissue in the alveolar fossa and the bacteria and inflammatory tissue in the periapical bone destruction area. The results showed no significant difference between the CAP and No-CAP groups in the gray value of the apical bone destruction area and the surrounding bone tissue 5 years after loading of immediate dental implant restoration. This indicated that the mandibular molars with various inflammatory periapical bone tissue lesions could be effectively removed by improving the implant socket approach during immediate implant placement to promote bone tissue reconstruction.

At the same time, this study also has some limitations. This study is a retrospective study, the credibility of the findings is weaker, and strict inclusion and exclusion criteria were set in this study to minimize variables that are not relevant to the purpose of the study. The research sample of this study is small and cannot accurately represent the situation of the sample population. The study cases were all patients with good compliance, which caused a certain selection bias in this study. In the future, we will conduct a prospective study corresponding to this study to expand the sample size and follow-up time, and further explore the soft and hard tissue conditions of immediate dental implantation in mandibular molars with CAP.

CONCLUSION

The results of this study suggest that immediate implant placement of the mandibular molars with CAP can achieve satisfactory 5-year clinical results, without significant differences in the complications, survival rate, or bone tissue condition from No-CAP mandibular molars.

ARTICLE HIGHLIGHTS

Research perspectives

Immediate implant placement of mandibular molars with chronic apical periodontitis (CAP) can achieve good clinical outcomes.

Research conclusions

The results of this study suggest that immediate implant placement of the mandibular molars with CAP can achieve satisfactory 5-year clinical results, without significant differences in the complications, survival rate, or bone tissue condition from No-CAP.

Research results

The peri-implant bone density was 528.2 ± 78.8 Hounsfield (HU) in the CAP group and 562.6 ± 82.9 HU in the No-CAP group 5 years after implant placement. The peri-implant bone density did not differ significantly between the two groups. The marginal bone resorption or jump gap did not differ significantly between the two groups. In the CAP area, the gray values of the bone tissue immediately and 5 years after implant placement differed significantly from those of the surrounding bone tissue ($P < 0.01$).

Research methods

This study was to retrospectively analyze and compare the 5-year outcomes of immediate implant placement of mandibular molars with CAP and those without obvious inflammation by quantitative study of peri-implant bone mass changes using Simplant software and Image J software.

Research objectives

Immediate implant placement of the mandibular molars with CAP can achieve satisfactory 5-year clinical results.

Research motivation

Most physicians consider molars with CAP lesions as contraindications for immediate implant placement.

Research background

At the request of the patient, we tried to immediate implant placement of mandibular molars with CAP in clinical work.

Figure Legends

Figure 1 Patients' screening flow chart.

Figure 2 . A-C: Computed tomography (CT) images of the chronic apical periodontitis (CAP) group before surgery; D-F: CT images of the CAP group after immediate dental implantation; G-I: CT images of the CAP group 5 years after restoration.

Figure 3 Immediate implantation surgery and repair in the chronic apical periodontitis group. A: 36 were examined before surgery; B: The gingiva was incised and the mucoperiosteal flap was raised, and then removed 36; C: Remove the inflammatory tissue in the extraction fossa, and the primary implant hole was prepared; D: Residual inflammatory tissue on bone wall of inflammatory lesion area was removed by ball drill through primary implant hole; E: Removed teeth and removed inflammatory tissue; F: Immediate implant placement; G: Non-embedding healing; H: Gum cuff; I: Crown restoration completed.

Figure 4 Method for measuring changes in bone tissue around implants. A: The peri-implant bone mineral density was measured by Simplant software; B: Schemas of marginal bone resorption and jump gap measurements. L0 is the long axis of the implant, L1 is perpendicular to L0, H1 is the vertical distance from the crest of the alveolar bone to L1, W1 is the horizontal distance from the most lateral side of the alveolar bone wall to the edge of the implant, H2 is the vertical distance from the highest point of contact between the implant and bone to L1, and W2 is the width of the jump gap; C: Image J software was used to measure the gray value of the bone destruction area at the root apex of the affected tooth (the gray value of alveolar bone CBCT can reflect its bone mineral density).

Figure 5 Changes in bone tissue around implants. A: Vertical edge bone absorption of peri-implant (Buccal $P = 0.268$, Lingual $P = 0.526$); B: Horizontal edge bone absorption of peri-implant (Buccal $P = 0.428$, Lingual $P = 0.560$); C: Implant-bone contact peak increment (Buccal $P = 0.247$, Lingual $P = 0.604$); D: The change in the jump gap (Buccal $P = 0.527$, Lingual $P = 0.707$).

Table 1 Age range of the patients

Group	Max	Min	Mean	SD	*P*-value
CAP group (*n* =52)	68	18	35.6	5.28	0.385
No-CAP group (*n* =45)	66	20	36.8	4.79	

CAP: chronic apical periodontitis.

Table 2 Gender of the patients

Group	Sex		Total	*P*-value
	Female	Male		
CAP group (*n* =52)	28	24	52	0.314
No-CAP group (*n* =45)	19	26	45	
Total (*n* =97)	47	50	97	

CAP: chronic apical periodontitis.

86053.docx

ORIGINALITY REPORT

3%
SIMILARITY INDEX

PRIMARY SOURCES

1	www.ncbi.nlm.nih.gov Internet	106 words — 2%
2	"Research Competitions (Oral Presentations) (Abstracts 1 to 18)", Clinical Oral Implants Research, 09/2009 Crossref	16 words — < 1%
3	"ABSTRACTS", Clinical Oral Implants Research, 10/2007 Crossref	12 words — < 1%

EXCLUDE QUOTES	ON	EXCLUDE SOURCES	< 12 WORDS
EXCLUDE BIBLIOGRAPHY	ON	EXCLUDE MATCHES	< 12 WORDS