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Evaluation of Dental Radiographic Imaging among Insured Population Reporting for Dental Treatment –A Retrospective Study

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Abstract		Original Research Article

Aim: To evaluate various dental radiographic examination techniques carried out among insured population. *Material and method:* This was a retrospective study performed among patients reported to Department of Dentistry, ESIC Medical College, Hyderabad during a two year period from January 2017 to December 2018. Records of 11,535 patients who required radiographic investigations like intraoral periapical radiograph (IOPAR), Orthopantamogram (OPG), Computerized Tomogram (CT) and Cone beam computerized tomogram (CBCT) for diagnosis and treatment planning were analyzed. *Results*: Among the 11,535 patients, a total of 9,193 IOPAR, 1936 OPG, 348 CT, and 58 CBCT were taken. Among IOPAR, 6164 (67.05%) were advised to diagnose dental caries, 1514 (16.47%) for periodontal disease, and 636 (6.92%) for dental trauma. Regarding OPG, 485(25.05%) were advised to diagnose maxillofacial trauma, 338(17.46%) for periodontal disease, and 224 (11.57%).With regards to CT, 308(88.51%) were advised to diagnose maxillofacial trauma and 40(11.5%) were advised for Cysts and Tumours. In 58 instances where CBCT was advised 47(81.04%) were advised to diagnose Cysts and Tumours and 11(18.96%) were advised for maxillofacial trauma. *Conclusion:* About 17.07% (11,535 out of 67,551) of the Out-patients required radiological investigations. Among them IOPAR was most commonly advised while the least was CBCT. IOPAR was gold standard for Dental caries and its sequel, and for periodontitis. OPG was ideal for multiple teeth lesions; however had the drawback of ghost images. CT gives a good 3D view but has high radiation exposure and is expensive. CBCT is advanced and gave realistic anatomical picture with comparatively less radiation. However, its availability and standing posture are the drawbacks.
Keywords: Radiographs, Radiation, Dentistry, Insured population, Diagnosis, Treatment.

INTRODUCTION

Orofacial pain is a major health issue, differentiating odontogenic and non-odontogenic pain involves various diagnostic aids. Diagnosis is a personal and cognitive experience. Hence adequate knowledge, experience and diagnostic tools aids in accurate diagnosis. Amongst several diagnostic aids radiographs are commonly used, easily available and cost effective [1].

In 1895, Wilhelm Conrad Roentgen, a German mechanical engineer and physicist, produced and detected electromagnetic radiation in a wavelength range known as X-rays or Rontgen rays. Fourteen days after Roentgen's first publication, Dr. Otto Walkhoff captured the first dental radiograph of his own teeth for an exposure time of 25 min and from then on advances in dental radiographic imaging techniques are still in progress. Radiographs have now become inevitable in dental practice for diagnosis, treatment planning and follow-up [2].

Clinical diagnosis based on subjective symptoms may be influenced by the level of anxiety of the patients. Radiographs then play a major role in proper diagnosis, treatment plan and surgical outcome. It helps preoperatively to determine the quantity, quality of underlying bone and angulations of teeth, and to estimate the pathology [3]. Apart from Diagnosis and Treatment planning, it also aids in evaluating effectiveness of treatment performed, prognosis of

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identified disease, overall investigation information and Medico-legal documentation [4].

There are several radiographic imaging techniques used in field of dentistry such as intraoral radiographs- IOPA, Bitewing, Occlusal radiographs. Extraoral radiographs include- OPG, Cephalogram, CT, and CBCT. Among them IOPA, OPG, CT, CBCT are most commonly used. The present study was carried out to assess the statistical data of radiographic investigations carried out among insured population of Hyderabad.

MATERIAL AND METHOD

The present study was conducted as a retrospective study performed utilizing data of patients who reported to the Department of Dentistry, ESIC Medical College, and Hyderabad during a 2 years period ranging from January 2017 to December 2018. Records of patients who were advised radiographic examination depending on clinical requirement for diagnosis and treatment plan were utilized for the analysis. Parameters evaluated were age, gender, clinical diagnosis and radiographic investigation advised. Records of patients with incomplete information were excluded from the study. The obtained data were categorized based on age as <15years, 16-30years, 31-45years and >45years. For the purpose of the study, clinical diagnosis of the condition of the patients was categorized into one of the following: (i) Dental caries, (ii) Periodontal disease, (iii) Dental trauma, (iv) Maxillofacial trauma, (v) Cyst and Tumors, (vi) Missing teeth, (vii) Wasting diseases, (viii) Impacted teeth, (ix) Space infections, and (x) TMJ problems.

Frequency of age and Gender distribute on according to the dental problem was analyzed. The significance of radiograph for specific dental problem was recorded. These specifications and assimilation of data prevents unnecessary radiation exposure and aids in focused treatment plan.

RESULTS

A total of 6582 radiographs were advised among males, among them 79.99% (5265) were IOPAR, 16.71% (1100) were OPG, 2.86% (188) were CT and 0.44% (29) was CBCT. A total of 4953 radiographs were advised among females, among them 79.31% (3928) were IOPAR, 16.88% (836) were OPG, 3.23% (160) were CT and 0.59% (29) was CBCT as shown in Table 01.

A total of 1294 IOPAR were taken among <15 years age group, among them majority (71.9%, 929) were advised for dental caries followed by 15.22% (197) for periodontal disease, 5.02% (65) for dental trauma, 7.96% (103) for cysts and tumours, missing teeth, wasting diseases, impacted teeth. A total of 2376 IOPAR were advised among 16-30 years age group,

among them majority (65.57%, 1558) were advised for dental caries followed by 16.62% (395) for periodontal disease, 6.78% (161) for dental trauma, 11.03% (262) for cysts and tumours, missing teeth, wasting diseases, impacted teeth. A total of 3344 IOPAR were advised among 31-45 years age group, among them majority (67.34%, 2252) were taken for dental caries followed by 17.31% (579) for periodontal disease, 6.58% (220) for dental trauma, 8.76% (293) for cysts and tumours, missing teeth, wasting diseases, impacted teeth as shown in Table 02.

A total of 305 OPG were taken among <15 years age group, among them majority (31.48%, 96) were advised for maxillofacial trauma, followed by 19.02% (58) for periodontal disease, 13.11% (40) for dental caries, 12.13% (37) for impacted teeth, 8.2% (25) for missing teeth, 16.06% (49) for dental trauma, cysts and tumours, wasting diseases, space infections, TMJ problems. A total of 567 OPG were advised among 16-30 years age group, among them majority (27.69%, 157) were taken for maxillofacial trauma, followed by 17.64% (100) for periodontal disease, 13.4% (76) for impacted teeth, 9.7% (55) for dental caries, 7.94% (45) for missing teeth, 6.35% (36) for cysts and tumours, 6.17% (35) for dental trauma, 11.1% (63) for wasting diseases, space infections, TMJ problems. A total of 627 OPG were taken among 31-45 years age group, among them majority (19.94%, 125) were advised for maxillofacial trauma, followed by 18.66% (117) for periodontal disease, 10.69% (67) for dental caries and impacted teeth, 7.94% (45) for missing teeth 10.05% (63) for missing teeth,8.29% (52) for cysts and tumours, 7.18% (45) for dental trauma, 14.51% (91) for wasting diseases, space infections, TMJ problems. A total of 437 OPG were advised among >46 years age group, among them majority (24.49%, 107) were advised for maxillofacial trauma, followed by 14.42% (63) for periodontal disease, 14.19% (62) for dental caries and impacted teeth, 12.13% (53) for missing teeth, 20.59% (90) for cysts and tumours, dental trauma, wasting diseases, space infections, TMJ problems as shown in Table 03.

A total of 30 CT were advised among <15 years age group, among them 90% (27) were advised for maxillofacial trauma and the remaining 10% (3) were advised for cysts and tumours. A total of 102 CT were advised among 16-30 years age groups, among them 89.22% (91) were advised for maxillofacial trauma and the remaining 10.78% (11) were advised for cysts and tumours. A total of 127 CT were advised among 31-45 years age groups, among them 88.19% (112) were taken for maxillofacial trauma and the remaining 11.81% (11) were taken for cysts and tumours. A total of 89 CT were taken among >45 years age group, among them 87.64% (78) were advised for maxillofacial trauma and the remaining 12.36% (11) were advised for cysts and tumours as shown in Table 04.

A total of 5 CBCT were advised for Cysts and tumours among < 15 years age group. A total of 17 CBCT were advised among 16-30 years age groups, among them 82.35% (14) were advised for Cysts and tumours and the remaining 17.65% (3) for maxillofacial trauma. A total of 25 CBCT were taken among 31-45 years age groups, among them 80% (20) were advised for Cysts and tumours and the remaining 20% (5) for maxillofacial trauma. A total of 11 CBCT were advised among >46 years age group, among them 72.73% (8) was advised for Cysts and tumours and the remaining 27.27% (3) for Maxillofacial trauma as shown in Table 05.

Table-01: showing Gender Distribution

Investigation aid	Males		Females		Total	
	N	%	N	%	N	%
IOPAR	5265	79.99	3928	79.31	9193	79.70
OPG	1100	16.71	836	16.88	1936	16.78
CT	188	2.86	160	3.23	348	3.02
CBCT	29	0.44	29	0.59	58	0.50
Total	6582	100.00	4953	100.00	11535	100.00

Table-02: Showing IOPAR distribution as per Age and Pathology.

Dental problem	IOPAR									
	<15 Years		16-30 years		31-45 years		>45 years		Total	
	N	%	N	%	N	%	N	%	N	%
Dental caries	929	71.79	1558	65.57	2252	67.34	1425	65.40	6164	67.05
Periodontal disease	197	15.22	395	16.62	579	17.31	343	15.74	1514	16.47
Dental trauma	65	5.02	161	6.78	220	6.58	190	8.72	636	6.92
Maxillofacial trauma	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Cysts and Tumours	25	1.93	91	3.83	106	3.17	85	3.90	307	3.34
Missing teeth	27	2.09	54	2.27	78	2.33	56	2.57	215	2.34
Wasting diseases	16	1.24	37	1.56	44	1.32	24	1.10	121	1.32
Impacted teeth	35	2.70	80	3.37	65	1.94	56	2.57	236	2.57
Space infections	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
TMJ problems	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Total	1294	100.00	2376	100.00	3344	100.00	2179	100.00	9193	100.00

Table-03: Showing OPG advised as per age and Pathology

Dental problem	OPG									
	<15 Years		16-30 years		31-45 years		>46 years		Total	
	n	%	n	%	n	%	n	%	N	%
Dental caries	40	13.11	55	9.70	67	10.69	62	14.19	224	11.57
Periodontal disease	58	19.02	100	17.64	117	18.66	63	14.42	338	17.46
Dental trauma	9	2.95	35	6.17	45	7.18	19	4.35	108	5.58
Maxillofacial trauma	96	31.48	157	27.69	125	19.94	107	24.49	485	25.05
Cysts and Tumours	9	2.95	36	6.35	52	8.29	26	5.95	123	6.35
Missing teeth	25	8.20	45	7.94	63	10.05	53	12.13	186	9.61
Wasting diseases	9	2.95	18	3.17	22	3.51	14	3.20	63	3.25
Impacted teeth	37	12.13	76	13.40	67	10.69	62	14.19	242	12.50
Space infections	13	4.26	27	4.76	36	5.74	18	4.12	94	4.86
TMJ problems	9	2.95	18	3.17	33	5.26	13	2.97	73	3.77
Total	305	100.00	567	100.00	627	100.00	437	100.00	1936	100.00

Table-04: Showing CT distribution as per Age and Pathology

Dental problem	CT									
	<15 Years		16-30 years		31-45 years		>46 years		Total	
	n	%	N	%	n	%	n	%	n	%
Maxillofacial trauma	27	90	91	89.22	112	88.19	78	87.64	308	88.51
Cysts and Tumours	3	10	11	10.78	15	11.81	11	12.36	40	11.49
Total	30	100	102	100.00	127	100.00	89	100.00	348	100.00

Table-05: Showing CBCT distribution as per age and pathology

Dental problem	CBCT									
	<15 Years		16-30 years		31-45 years		>46 years		Total	
	N	%	N	%	N	%	N	%	N	%
Maxillofacial trauma	0	0	3	17.65	5	20	3	27.27	11	18.97
Cysts and Tumours	5	100	14	82.35	20	80	8	72.73	47	81.03
Total	5	100	17	100	25	100	11	100.00	58	100.00

DISCUSSION

The study was conducted to analyze the usage of radiographs among patients reporting for dental treatment at ESIC Medical College and Hospital, Hyderabad. The institution caters to the healthcare needs of individuals covered under the ESI scheme, a state-sponsored social security scheme for workers in the organized sector and their dependent family members. It is an institute where along with general dentistry, specialty practice is being undertaken such as endodontic treatments, periodontal flap surgeries, prosthetic rehabilitation, surgical extractions, cyst enucleation, apicectomy, open reduction and internal fixation of fracture maxilla and mandible. To undertake these procedures radiographs are of importance for proper outcome.

Conventional radiographs produce two-dimensional (2D) image of a three-dimensional (3D) object. They provide excellent insight into internal structure of teeth and underlying bone, periodontal and periapical diseases and other osseous conditions. However, it causes superimposition of overlying structures and results in collapsing 3D structural information on to 2D image, which further results in loss of spatial information [2].

During the study period, a total of 67,551 patients attended the Dental OPD. Among them, 11535 patients (6582 among males and 4953 among females) were advised radiographs. The proportion of patient advised the various radiographs were similar in both the gender groups. Radiographs were prescribed for caries lesions involving enamel, dentine, pulp, periodontal diseases, and periapical pathology. IOPAR was advised for (i) caries lesions in 6164 (67.05%) patients for which treatments ranged from Restorations to Root canal treatment (ii) periodontitis in 1514 (16.47%) patients for which extraction, root canal treatment, flap surgery, composite splint were performed, (iii) dental trauma in 636 (6.92%) patients for which extraction was done in cases of retained root apices while splinting with arch bar, bridle wiring or composite splinting was done for stabilizing subluxated or extruded teeth.(iv) periapical cysts which required IOPAR was 307 (3.34%) for which management was cyst enucleation, Apicectomy. (v) Missing teeth in 215 (2.34%) patients where quality of bone and condition of adjacent teeth was assessed, and (vi) Wasting diseases in 121 (1.31%) patients where restoration, root canal treatment or extraction was performed. (vii) Presence of impacted teeth in 236 (2.57%) patients where surgical removal of tooth was performed. (viii) Space infection (4.86%) where Incision and Drainage or extraction was done.

Priya *et al.,* has concluded in their study that IOPA had an edge over OPG in third molar surgical cases in determining relationship of the external oblique ridge, antero-posterior relation with ramus, vertical depth of impaction, number of roots, morphology of roots, whereas OPG was found to be accurate in evaluating the type of impaction, canal relation, along with morphology of root of impactedteeth [5]. In case of patient undergoing root canal treatment IOPAR was the gold standard before, during, and after treatment to evaluate anatomical details, working length, master cone, obturation quality, and periapical pathology [6]. Intraoral radiographic films are available as D, E and F speed films. It is reported that switching from D to E speed film reduces radiation by 30%-40% and from D to F by 60%. Digital X ray require a much lower radiation exposure, i.e., 50%-75% less than equivalent film image [7]. However in patients with periocoronitis or trismus, placement of IOPA film was difficult.

In our study, it was observed that OPG was the next most commonly advised radiograph (n=1936, 16.71 % in males, 16.88% in females). It is a technique commonly preferred as it covers multiple teeth or wide maxillofacial region involving anatomically important structures. The major advantages are the broad coverage, low radiation exposure (about 10% of a full-mouth radiographs), and relatively inexpensiveness of the equipment. OPG was advised for 1)Subjects with maxillofacial trauma specially mandible were advised OPG in 485 (25.05%) patients where it aided in

evaluating paramphysis, body, angle, ramus, condyle and coronoid fractures followed by 2) Periodontal diseases in 338 (17.46%) patients where more than 3-4 teeth are involved, 3) Subjects with trismus due to presence of impacted teeth in 242 (12.5%) 4) Caries lesions in 224 (11.57%) patients involving 3rd molars specially buccally erupted maxillary molars 5)Maxillofacial pathology like odontogenic cyst are evaluated in 123 (6.36%) patients, space infections in 94 (4.86%) patients who had involvement of canine, buccal, submental, submandibular, submassteric space, pterygomandibular and Ludwig's. 6) TMJ problems in 73 (3.77%) cases to asses glenoid fossa and condyle. TahaEmreKose *et al.* [8] has done study in 743 edentulous asymptomatic patients requiring removable or implant prosthesis to rule out impacted teeth, retained root fragments, foreign bodies, and severe atrophy of the posterior maxillary alveolar bone, mucous retention cysts, and soft tissue calcifications. However, drawbacks are lower image resolution, high distortion and presence of phantom images [9].

CT was advised in 348 patients specially 1) Subjects with pan trauma and pan facial trauma (n=308, 88.51%) as it is taken simultaneously maintaining same supine position in same appointment where multi fractures can be evaluated. This is easily available despite its high radiation exposure2) Subjects with other maxillofacial pathologies (n=40, 11.5%) where it gives 3Dimensional reconstruction views. It gives detailed description of anatomically important landmarks which aids for proper treatment plan and giving patient realistic expectation and obtaining proper consent.

Trope *et al.* [10] in 1989 used CT scans to differentiate radicular cysts from granulomas based on marked difference in density between the content of the cyst cavity and granulomatous tissue. It distinguishes between intrinsic and extrinsic salivary tumors and is used for staging tumors [11]. However CT is got few disadvantages such as high radiation exposure, expensive and poor resolution.

Rajathi J *et al.* [12] has done study in 10subjects to localise maxillary impacted canine using IOPAR Slob technique and buccopalatal position, OPG, CT and concluded that CT was gold standard and resembled exact surgical exposed site. However, the disadvantage of CT scan as a routine diagnostic examination is the high cost and the high level of radiation dose to the patient. In dental arches, the effective radiation dose while taking CT is 0.21 mSv, which is the equivalent of 26 days of natural background radiation dose. In OPG, the dosage is estimated at 0.03 mSv, which is the equivalent of 4 days of natural background radiation dose [13].

CBCT is advised least (n=58 despite its good quality and low radiation, is due to its non-availability in our Unit. 1) Maxillofacial pathology (n=47, 81.04%),

and 2) Maxillofacial trauma (n=11, 18.96%). Hence use of CBCT is less frequent. Radiation dose of one cone beam computed tomography (CBCT) scan may be as little as 3%-20% that of a conventional CT scan, depending on the equipment used and the area scanned [14].

Tang *et al.* [15] has measured alveolar bone on CBCT and OPG (with varying vertical magnification both horizontally and vertically at incisors and molars) and concluded that measurements made were highly correlating to each other. CBCT had an edge over OPG and CT in terms of 3Dimensionally defining the lesion, surrounding anatomical landmarks, able to change the view on the system. It is also suggested by some authors that there is a better correlation between CBCT scans and IOPAR scores than between CBCT scans and OPG images scores due to the paralleling technique [16].

As per European Academy of Dento-Maxillofacial Radiology guidelines [17], the Effective dose of one intraoral radiograph is 1.5 μSv. As described by other studies effective dose of conventional OPG is 3.85-38.0 μSv, for a lateral cephalogram is 1.1-5.6 μSv, for posteroanterior cephalogram, 5.1 μSv, and for one intraoral radiograph, 0.65-9.5 μSv. CBCT delivers an equivalent patient radiation dose of 5 to 74times that of a panoramic X - ray or 3 to 48 days of background radiation [18].

However radiation of CT is ten folds greater than CBCT, image quality for Soft tissue is better than CBCT, whereas image quality of hard tissue is equal for both [5].

CONCLUSION

IOPA is gold standard for less than 3-4teeth involving dentoalveolar component. IOPA and OPG are only a two-dimensional representation of a three dimensional entity. CBCT in dentistry is an advanced and more accurate diagnostic aid. CBCT imaging surpassed the obstacles of 2D imaging, offering practitioners with high quality, sub-millimeter resolution images, with short scanning time and low radiation dose. Inspite of disadvantages with OPG like Ghost image in symphysis region, proximity to maxillary sinus and mandibular canal discrimination difficulty OPG is being prescribed. Quadrant CBCT is equal to the price of OPG, time consumption is same, low radiation, hence advised in surgical cases. We as dentist perform many surgical procedures expecting good esthetic outcome with no recurrence of lesion. In order to achieve these goals, an advanced diagnostic aid is required for the benefit of the patients. Hence, it is extremely important that the best diagnostic aid is advised according to the clinical situation based on the latest advances.

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REFERENCES

1. Ingle, J. I., & Glick, D. H. (1994). Differential diagnosis and treatment of dental pain. *Endodontics*, *4*, 524-549.
2. Shah, N., Bansal, N., & Logani, A. (2014). Recent advances in imaging technologies in dentistry. *World journal of radiology*, *6*(10), 794.
3. Juodzbalys, G., & Kubilius, M. (2013). Clinical and radiological classification of the jawbone anatomy in endosseous dental implant treatment. *Journal of oral & maxillofacial research*, *4*(2).
4. Decusara, M. (2011). Use of orthopantomogram in dental practice: a statistical study. *Int Jr Med Dent*, *1*, 389-92.
5. Priya, P. V., Nasyam, F. A., Ramprasad, M., Penumatsa, N. V., & Akifuddin, S. (2016). Correlating the clinical assessment of impacted mandibular third molars with panoramic radiograph and intraoral periapical radiograph. *Journal of International Society of Preventive & Community Dentistry*, *6*(Suppl 3), S219.
6. Fava, L. R. G., & Dummer, P. M. H. (1997). Periapical radiographic techniques during endodontic diagnosis and treatment. *International Endodontic Journal*, *30*(4), 250-261.
7. Silva, M. A. G., Wolf, U., Heinicke, F., Bumann, A., Visser, H., & Hirsch, E. (2008). Cone-beam computed tomography for routine orthodontic treatment planning: a radiation dose evaluation. *American Journal of Orthodontics and Dentofacial Orthopedics*, *133*(5), 640-e1.
8. Kose, T. E., Demirtas, N., Karabas, H. C., & Ozcan, I. (2015). Evaluation of dental panoramic radiographic findings in edentulous jaws: A retrospective study of 743 patients. *The journal of advanced prosthodontics*, *7*(5), 380-385.
9. White, S. C., Heslop, E. W., Hollender, L. G., Mosier, K. M., Ruprecht, A., & Shrout, M. K. (2001). Parameters of radiologic care: An official report of the American Academy of Oral and Maxillofacial Radiology. *Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontology*, *91*(5), 498-511.
10. Trope, M., Pettigrew, J., Petras, J., Barnett, F., & Tronstad, L. (1989). Differentiation of radicular cyst and granulomas using computerized tomography. *Dental Traumatology*, *5*(2), 69-72.
11. Stone, D. N., Mancuso, A. A., Rice, D., & Hanafee, W. N. (1981). Parotid CT sialography. *Radiology*, *138*(2), 393-397.
12. Rajathi, J. M., Austin, R. D., Ramasamy, S., & Mathew, P. (2014). Validation of dental panoramic radiographs for the localization of impacted maxillary canines. *Indian Journal of Oral Sciences*, *5*(1), 10.
13. BUSHHONG, S. (1988). Radiologic Science for Technoligists. *Physics, Biology, and Protection.*, 485-490.
14. White, S., & Pharaoh, M. (2004). Advanced imaging modalities. *Oral radiology: principles and interpretation*.
15. Tang, Z., Liu, X., & Chen, K. (2017). Comparison of digital panoramic radiography versus cone beam computerized tomography for measuring alveolar bone. *Head & face medicine*, *13*(1), 1-7.
16. European Commission. (2012). Radiation Protection No. 172. Cone Beam CT for Dental and Maxillofacial Radiology-Evidence Based Guidelines.
17. Schulze, D., Heiland, M., Thurmann, H., & Adam, G. (2004). Radiation exposure during midfacial imaging using 4-and 16-slice computed tomography, cone beam computed tomography systems and conventional radiography. *Dentomaxillofacial Radiology*, *33*(2), 83-86.
18. Danforth, R. A., & Clark, D. E. (2000). Effective dose from radiation absorbed during a panoramic examination with a new generation machine. *Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontology*, *89*(2), 236-243.