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RADIOGRAPHIC EVALUATION OF CRESTAL BONE RESORPTION DURING HEALING & LOADING PERIOD IN IMPLANT SUPPORTED OVERDENTURE BY PLACING IMPLANT THROUGH FLAP TECHNIQUE- IN VIVO STUDY

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Abstract

Aim: The aim of this study was to detect the effect of flap technique on crestal bone resorption during healing and loading period in implant supported overdentures.

Material and Methods: A total of 8 patients, 5 male and 3 female, ranging from 50 to 70 years of age, having completely edentulous maxillary and mandibular arches were selected for the study the whole study was conducted in 4 phases. In the 1st phase Clinical Diagnosis, Treatment Planning & Denture Fabrication was done. The selected subjects will be diagnosed and treatment planning for new denture fabrication was done. In the 2nd phase the denture insertion was done and if required occlusal correction was be performed. After initial recall visit, patient was recalled again after one week of denture usage. In this visit 1st stage of implant surgery was conducted. Dental implant in the mid symphyseal region was placed following all the surgical protocols. Immediately after surgery first IOPA with RVG was taken. After the surgery the denture was relieved at the surgical site and patient was asked to use the same denture. Subsequently after 4 weeks and after 12 weeks of healing the second and third IOPA with RVG was taken. The computer software was used for measuring the bone level. After 3 months of Osseointegration period in phase 3, the loading of the implant was done by incorporating O ring attachment. Again after 4 weeks and after 12 weeks of loading the fourth and fifth IOPA with RVG was taken. The magnification error was checked. The data obtained was saved using Paint software used in Microsoft 8.1. The data so obtained for measuring the bone levels with the help of computer software (RVG 5100) was tabled and statistical analysis was done.

Results: The mean rate of crestal bone loss with time was more during first month (0.35mm) then it decreased in 3rd month (0.51mm) and further decreased during 4th month (0.59mm) and 6th month (0.70mm) follow up period.

Conclusion: The concept of single implant supported overdentures provides another option for completely edentulous elderly patients with severely resorbed mandibular ridge & with economic constraints in developing countries.

Keywords: Dental implants, Overdenture, Residual Alveolar Ridge, Crestal Bone loss, Intraoral Digital Radiography (RVG 5100).

Introduction

It is very difficult to rehabilitate an edentulous patient with a compromised mandibular alveolar bone because it often results in denture soreness, poor retention & stability along with improper speech and low chewing efficiency. Implant-retained overdentures are widely used for the rehabilitation of edentulous jaws to increase retention of prosthesis, to enhance the masticatory function and reduce the absorption of alveolar bone by regulating neuromuscular adaptation.[1]

The York consensus statement recommends at least two implants to support mandibular overdentures for edentulous patients. However, economic constraints especially among the emerging elderly population in developing countries make ours treatment strategy financially is challenging. In order to reduce the cost and time of treatment, the concept of single implant retained overdentures provides another option for elderly populations.[1]

Problems encountered with two implant retained overdentures like both implant should be parallel to each other, should be equidistant from the midline & should be at same level to each other and failure of one may lead to unequal stresses on the other. All these can be avoided in case of single implant retained overdentures.[2]

The longevity and success of dental implants with prosthesis is highly dependent on integration between implant components and oral tissues, including hard and soft tissues. Initial breakdown of the implant-tissue interface generally begins at the crestal region in successfully osseointegrated endosteal implants. In particular, after the first year of function, crestal bone loss upto or beyond the first thread of titanium screw implants, characterized by “saucerization,” is often observed radiographically around certain implant types.[2]

Many possible etiologies of early crestal bone loss around implants (from implant placement to 1-year post-loading) including surgical trauma, occlusal overload, peri-implantitis, the presence of microgap, reformation of biologic width, implant crest module and others have been proposed. However, the location of dental implants, whether subcrestal or supracrestal, is still becoming increasing importance for researchers.[3]

Non-submerged implants also have demonstrated early crestal bone loss, with greater bone loss in the maxilla than in the mandible, ranging 0.6 mm to 1.1 mm, at the 1st year of function. Another study that analyzed wide neck implants had been shown that the mean crestal bone loss around those implants at the mesial and distal sides was 0.71 mm and 0.60 mm, respectively.[3]

No matter whether bone loss around dental implants is the result of increased plaque accumulation, or an insufficient biologic width it can be stated that at least 1 mm of distance between the implant shoulder and the bone crest should be present when dental implants are inserted.[3]

Hence in this in-vivo study has been carried out to evaluate the crestal bone resorption during healing and loading period in single implant supported overdentures by placing implant through flap technique.

Materials & Methods

This prospective, in vivo study was carried out in the Department of Prosthodontics and Crown & Bridge in collaboration with Department of Oral Medicine, Diagnosis & Radiology and Department Of Oral & Maxillofacial Surgery of Career Post Graduate Institute of Dental Sciences & Hospital, Lucknow, to evaluate the crestal bone loss in a single implant supported mandibular overdentures opposing a maxillary complete denture over a period of 6 months follow-up after implant placement. A total of 8 patients, 5 male and 3 female, ranging from 50 to 70 years of age, having completely edentulous maxillary and mandibular arches were selected for the study. All subjects were asked to sign a consent form, after explaining the deailed procedure in patient’s language (Hindi/English) about the implant treatment procedure. Ethical approval for the study was granted by the Ethical Committee of the Career Post Graduate Institute of Dental Sciences & Hospital, Lucknow. Each subject was clinically diagnosed, radiographically evaluated and the required blood investigations were carried out for the dental implant surgical procedure. The patients who were completely edentulous, Co-operative, healthy without any systemic diseases were included in the study. The patient having minimum 10mm of residual bone height available without augmentation (Class II or III according to McGarry et al.), unsatisfied with old conventional complete dentures and patients without any bone disorders were also included in the study. The patients with maxillofacial defects, suffering from systemic diseases, and having any type of tumor, neuromuscular disorders, neurologic or cerebrovascular diseases or hemorrhagic or severe cardiopulmonary disorders were excluded in the study. Materials used in the study were dust free regular set alginate (ALGITEX, India), improved Dental Stone (DENSTONE, India), light body consistency elastomeric impression material (EXPRESS ™ 3M ESPE, Germany), die stone (KALROCK, KALABHAI, India), tropical standard modeling wax (MODELING WAX, DPI India), cross linked acrylic teeth (HUGE KAILI, Germany), high impact heat cured acrylic resin (TREVALON HI, DENTSPLY, India), A-Silicon Gingival Mask (GINGIFAST, Zhermack Technical, Italy) low fusing impression compound (PINNACLE, DPI India), dental plaster (DEN TEX, India), self cured acrylic resin (RR COLD CURE, DPI India). Armamentarium used in the study are edentulous perforated metal stock trays, wax knife, wax spoon, lecron carver, straight spatula, curved spatula, hot plate, glass slab, dappen dish, self centering spring Face-bow (Hanau Wide Vue, USA), semi adjustable articulator (Hanau Wide Vue, USA), physiodispensor (Surgic XT, NSK, Japan), surgical and prosthetic implant kit (Equinox, Netherlands), endosseous Implant (Myriad Connect, Equinox, Netherlands), RVG (RVG 5100, KODAK Carestream), OPG (X Mind PANO CEPH, SETELEC, United Kingdom). The 8 subjects for the study were selected on the basis of inclusion and exclusion criteria after properly evaluating clinically. The whole study was conducted in 4 phases. Phase I included Clinical and radiographic diagnosis, Treatment planning, Maxillary and mandibular complete denture fabrication, Proper storage of complete denture till loading. Phase II included surgical procedure done for the placement of dental implant, digital radiographic evaluation of bone immediately after placement, digital radiographic evaluation of bone after a healing period of 4 weeks, digital radiographic evaluation of bone after a healing period of 12 weeks. Phase III included loading of the implant with complete denture, digital radiographic evaluation of bone 4 weeks after loading, digital radiographic evaluation of bone 12 weeks after loading. Phase IV included measurement of crestal bone loss using *measuring tool* operated in RVG software.

Phase I was subdivided into four stages of clinical and radiographic diagnosis, radiographic analysis, treatment Planning, denture fabrication, complete denture storage.

Clinical diagnosis was done by digital palpation of the ridge was done with two fingers sliding along the alveolar crest which helped to develop tactile sensation of the ridge, the presence of bony undercuts, irregularities in bone defects and soft tissue thickness. Ridge mapping is a simple and predictable procedure and it allows accurate measurement of bucco-lingual thickness of alveolar bone in the edentulous area prior to implant placement. The implant site was anesthetized and a specially designed bone caliper (GDC, India) was penetrated through the soft tissue until the surface of the bone was reached. An accurate reading of ridge thickness was achieved using a millimeter scale attached to the caliper to determine the diameter of the implant to be used.

Radiographic analysis was done by standardized Digital Orthopantogram (OPG) (X Mind Pano Ceph, Setelac, UK) and intraoral digital radiography (RVG 5100, Carestream) radiographs using a Bisecting Angle technique of the implant were obtained. The radiographs were taken to ascertain vertical bone height and quality and to rule out any intra-bony pathology in the area. Images were displayed on the computer screen with such a dimension and brightness that the observer could read the image comfortably and accurately.

After clinical and radiographic examination treatment was planned so as to place a single dental implant in the mid symphysis region (described as C position by Carl Misch) following all the surgical protocols after denture fabrication. Conventional complete denture was fabricated taking care of all the clinical and laboratory steps involved for its fabrication. It was stored in 0.2% diluted solution of chlorhexidine and changing solution.

Phase II involved surgical procedure, digital radiographic evaluation of bone immediately after placement, Digital Radiographic evaluation of bone after 4 weeks of healing period, Digital Radiographic evaluation of bone after 12 weeks of healing period.

Surgical procedure was planned after thorough clinical evaluation of the proposed implant site, a regular platform soft tissue level implant (Myriad, Netherland) with a diameter of 3.8 or 4.3 mm and 9.5 or 11 mm in length was selected. A retentive anchor with a titanium matrix (2mm height) was selected for the prosthetic anchorage.The osteotomy site was prepared according to the manufacture's direction using a standard bone drilling protocol, with extreme care to avoid penetration of the lingual or inferior cortex after raising mucoperiosteal flap. Initial implant stability was achieved with torques >35 Ncm and was tested manually by hand. Healing abutment of appropriate length was connected and mucosa was approximated and sutured with (4-0) silk. Antibiotics (Augmentin 625 mg) and non steroidal anti-inflammatory (Ibrufen 400mg) medications were given to the patients 8 hourly for 5 days postoperatively. Immediately after surgery, all patients were allowed to take soft diet for 3 days and were also advised to maintain good oral hygiene.

First Digital Radiographic evaluation of bone immediately after placement was done immediately after surger, first IOPA with RVG was taken. The dentures were relieved at the surgical site after the surgery and patients were asked to use the same denture. The denture insertions were done and occlusal correction was performed where required. Subjects were recalled again after one week of denture usage. Second Digital Radiographic evaluation of bone was done after one month of implant placement by using digital IOPA with bisecting angle technique. The data was saved for analysis of crestal bone loss. Third Digital Radiographic evaluation of bone was done after 12 weeks of healing period. Third digital IOPA was taken after one month of implant placement with bisecting angle technique. The data was saved for analysis of crestal bone loss in RVG 5100 software.

Phase III included loading of the implant with complete denture.

After 3 months of osseointegration period, the loading of the implant was done by incorporating O-ring attachment in the mandibular denture by relining the intaglio surface of denture with self cure acrylic. Forth Digital Radiographic evaluation of bone was done after the 4th week of loading by using 4th digital IOPA was taken with bisecting angle technique. The data were saved for analysis of crestal bone loss. Fifth digital IOPA was taken after three months (12 weeks) of implant loading with bisecting angle technique. The data was saved for analysis of crestal bone loss in RVG 5100 software.

Phase IV included measurement of Crestal Bone Loss using the standardized intraoral digital radiography (RVG 5100) for measuring the bone level using *measuring tool,* immediately after implant surgery, 1 month, 3 months, 4months and 6 months subsequently. The magnification error was checked. The data obtained was saved using Paint software used in Microsoft 8.1. The data so obtained for measuring the bone levels with the help of computer software (RVG 5100) was tabled and statistical analysis was done.

Figure 1: Materials used for complete denture fabrication

Figure 2.1: Bone Caliper

Figure 2.2: Armamentarium used for complete denture fabrication

Figure 2.3: Prosthetic implant kit

Figure 2.4: Myriad Connect endosseous implant

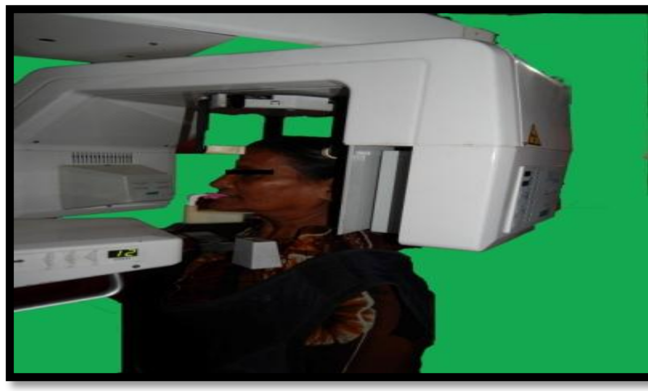


Figure 3.1: Radiographic diagnosis with O.P.G

Figure 3.2: Fabrication of complete denture

Figure 3.3: Minor surgery for implant placement

Figure 3.4.1: Shooting of R.V.G sensor

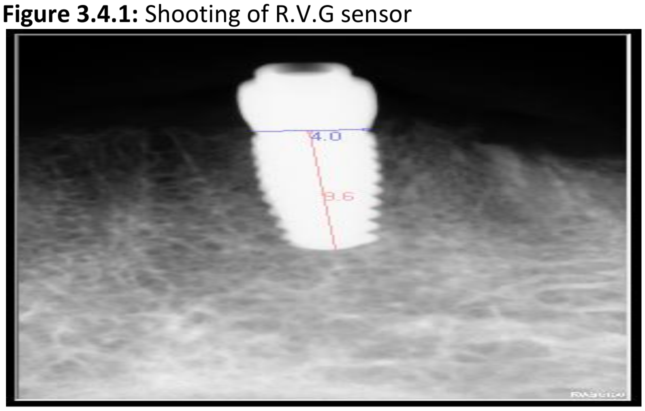


Figure 3.4.2: Measurement of crestal bone loss with R.V.G using *Measuring Tool*

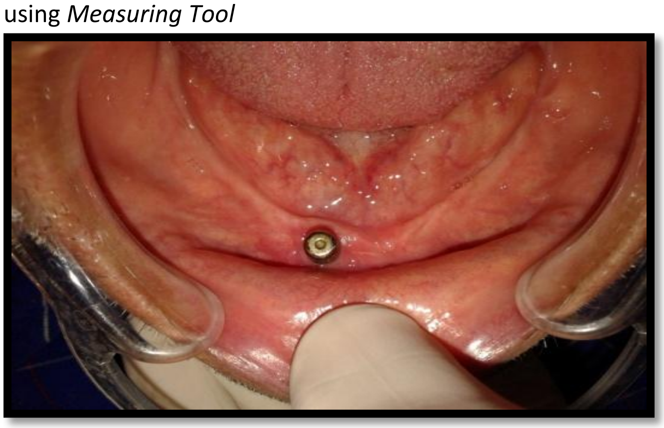


Figure 3.5: Gingival former placed over implant

Figure 3.6: Female housing in the intaglio surface of mandibular denture

Figure 3.7.1: Pre-treatment frontal view

Figure 3.7.2: Post-treatment frontal view

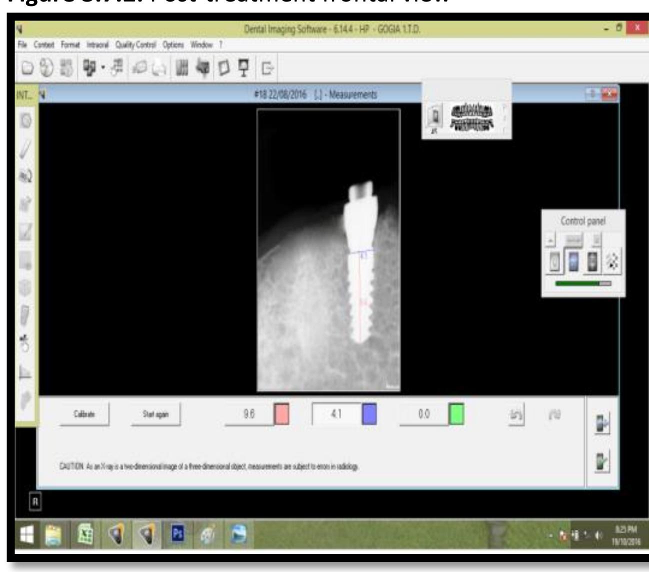


Figure 3.8: Storage of data using *Paint software* used in *Microsoft 8.1*

Statistical Analysis:

The data collected was subjected to relevant statistical analysis. The statistics that was calculated were arithmetic mean, the Standard deviation (σ), regression equation, curve regression, test of significance was calculated. *P*-value < 0.05 was considered to be significant.

Table 1: Showing crestal bone resorption during healing and loading period in implant supported overdentures over a period of 6 month follow up.

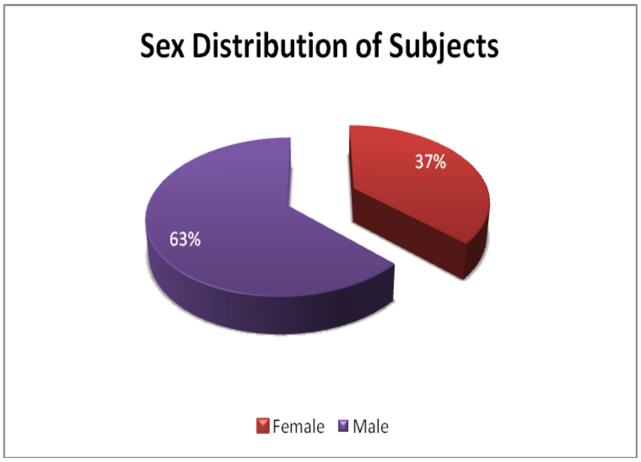
Subject No.	Age	Sex	Follow up	Radiographic implant length (mm)	Original implant Length (mm)	Magnification	Radiographic bone level (mm)	Original bone level(mm)	Crestal bone Level (mm)	% Crestal bone loss
1	60	M	Implant Placed	9.6	9.5	1.01	13.1	12.97	0	0
1	60	M	1st Month	9.4	9.5	0.99	12.8	12.9	0.07	0.53
1	60	M	3rd Month(Implant Loading)	9.5	9.5	0	12.6	12.6	0.37	2.85
1	60	M	4th Month	9.6	9.5	1.01	12.5	12.38	0.59	4.55
1	60	M	6th Month	9.5	9.5	0	12.2	12.2	0.77	5.94
2	70	F	Implant Placed	9.5	9.5	0	8.9	8.9	0	0
2	70	F	1st Month	9.7	9.5	1.02	8.6	8.43	0.47	5.28
2	70	F	3rd Month(Implant Loading)	9.6	9.5	1.01	8.5	8.41	0.49	5.5
2	70	F	4th Month	9.4	9.5	0.98	8.21	8.38	0.52	5.84
2	70	F	6th Month	9.6	9.5	1.01	8.3	8.21	0.69	7.75
3	60	F	Implant Placed	9.3	11	0.84	8.3	9.88	0	0
3	60	F	1st Month	9.4	11	0.85	8	9.41	0.47	4.76
3	60	F	3rd Month(Implant Loading)	9.3	11	0.84	7.8	9.29	0.59	5.97
3	60	F	4th Month	9.2	11	0.83	7.7	9.28	0.6	6.07
3	60	F	6th Month	9.4	11	0.85	7.8	9.17	0.71	7.17
4	56	M	Implant Placed	14.5	11	1.31	14.8	11.3	0	0
4	56	M	1st month	14.7	11	1.34	14.7	10.97	0.33	2.92
4	56	M	3rd Month(Implant Loading)	14.4	11	1.31	14.3	10.91	0.39	3.41
4	56	M	4th Month	14.5	11	1.31	14.2	10.84	0.46	4.07
4	56	M	6th Month	14.6	11	1.33	14.1	10.6	0.7	6.19
5	70	M	Implant Placed	12.2	9.5	1.28	12.8	10	0	0
5	70	M	1st Month	12	9.5	1.26	12.1	9.6	0.4	4
5	70	M	3rd Month(Implant Loading)	12.3	9.5	1.29	12.3	9.53	0.47	4.7
5	70	M	4th Month	12.2	9.5	1.28	12.1	9.45	0.55	5.5
5	70	M	6th Month	12.1	9.5	1.27	11.9	9.37	0.63	6.3
6	65	M	Implant Placed	11.1	11	1.01	12.4	12.28	0	0
6	65	M	1st Month	11.1	11	1.01	11.9	11.78	0.5	4.07
6	65	M	3rd Month(Implant Loading)	11.2	11	1.01	11.8	11.68	0.6	4.88
6	65	M	4th Month	11.1	11	1.01	11.7	11.58	0.7	5.7
6	65	M	6th Month	11	11	0	11.5	11.5	0.78	6.35
7	55	F	Implant Placed	11.1	11	1.01	10.4	10.3	0	0
7	55	F	1st MONTH	11	11	0	9.9	9.9	0.4	3.88
7	55	F	3rd Month(Implant Loading)	11.1	11	1.01	9.7	9.6	0.7	6.79
7	55	F	4th Month	11	11	0	9.6	9.6	0.7	6.79
7	55	F	6th Month	10.9	11	0.99	9.5	9.59	0.71	6.89
8	60	M	Implant Placed	9.4	9.5	0.99	12.2	12.32	0	0
8	60	M	1st Month	9.5	9.5	0	12.2	12.2	0.12	0.97
8	60	M	3rd Month(Implant Loading)	9.6	9.5	1.01	12	11.88	0.44	3.57
8	60	M	4th Month	9.4	9.5	0.99	11.6	11.72	0.6	4.87
8	60	M	6th Month	9.5	9.5	0	11.7	11.7	0.62	5.03

Observations & Results:

The mean ± SD of age of the subjects = 62.00±5.78

Table 2: Depicting sex distribution of subjects under study with 37% females and 63% males.

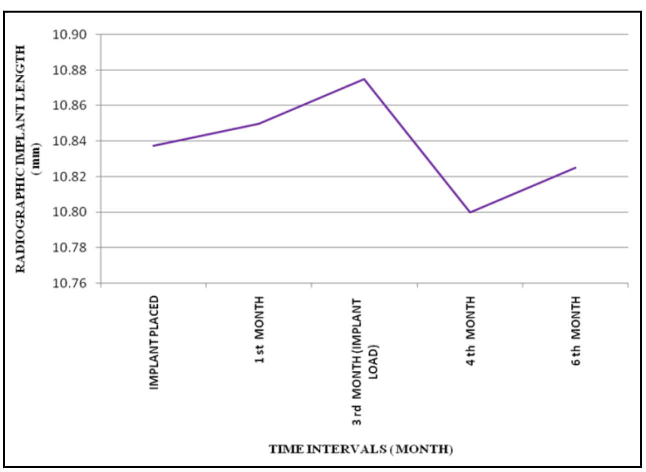
Sex	%
Female	37
Male	63



Graph 1: Representing subjects under study with 37% females and 63% males.

Table 3: Showing implant length measured radiographically at various time intervals.

Factor	Parameter	IMPLANT PLACED	1st MONTH	3rd MONTH (IMPLANT LOAD)	4th MONTH	6th MONTH
RADIOGRAPHIC IMPLANT LENGTH (mm)	Mean	10.84	10.85	10.88	10.80	10.83
	SD	1.82	1.84	1.78	1.84	1.81
	Min	9.30	9.40	9.30	9.20	9.40
	Max	14.50	14.70	14.40	14.50	14.60



Graph 2: Representing implant length which is either shortened or elongated radiographically at various time intervals. So radiographic measurement of crestal bone loss is subject to error in measuring crestal bone loss.

Table 4: Regression equations showing the relationship between implant lengths measured by radiography with various time intervals.

Equation	R Square	Parameter Estimates			
		Constant	b1	b2	b3
Linear	0.104	10.851	-0.004		
Quadratic	0.144	10.845	0.004	-0.001	
Cubic	0.415	10.832	0.061	-0.027	0.003

Here the cubic equation (R^2=0.415) showing the relationship between the implant length measured radiographically at different time intervals. This equation is given as follows

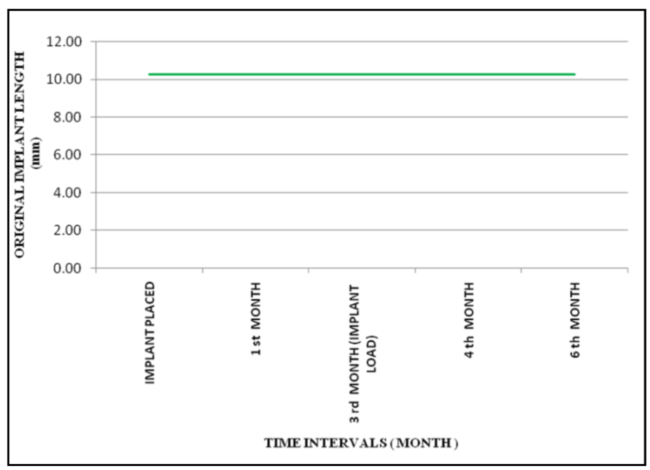
$$y = 0.003x^3 - 0.027x^2 + 0.061x + 10.832$$

Where y = Implant length measured by radiography

x = Time intervals

Table 5: Depicting original implant length measured at various time intervals.

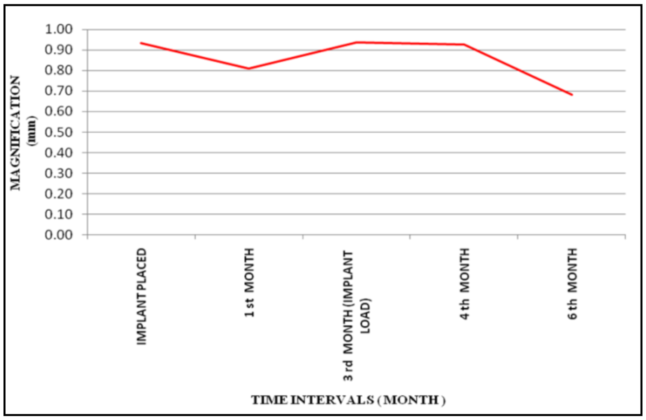
Factor	Parameter	IMPLANT PLACED	1st MONTH	3rd MONTH (IMPLANT LOAD)	4th MONTH	6th MONTH
ORIGINAL IMPLANT LENGTH (mm)	Mean	10.25	10.25	10.25	10.25	10.25
	SD	0.80	0.80	0.80	0.80	0.80
	Min	9.50	9.50	9.50	9.50	9.50
	Max	11.00	11.00	11.00	11.00	11.00



Graph 3: Representing the average original implant length which is constant for the various time intervals.

Table 6: Representing magnification at various time intervals.

Factor	Parameter	IMPLANT PLACED	1st MONTH	3rd MONTH (IMPLANT LOAD)	4th MONTH	6th MONTH
MAGNIFICATION	Mean	0.93	0.81	0.94	0.93	0.68
	SD	0.41	0.52	0.41	0.41	0.58
	Min	0.00	0.00	0.00	0.00	0.00
	Max	1.31	1.34	1.31	1.31	1.33



Graph 4: Showing magnification error occurred in radiographic evaluation of crestal bone level with various time intervals.

Table 7: Regression equations showing the relationship between magnification error with various time intervals.

Equation	R Square	Parameter Estimates			
		Constant	b1	b2	b3
Linear	0.291	0.929	-0.026		
Quadratic	0.637	0.866	0.066	-0.016	
Cubic	0.968	0.923	-0.177	0.093	-0.012

Here the cubic equation (R^2=0.968) showing the relationship between the magnification and different time interval. This equation is given as follows

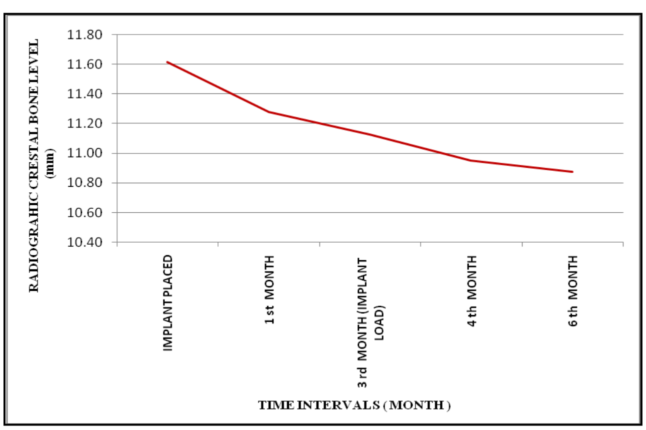
$$y = 0.012x^3 + 0.093x^2 - 0.177x + 0.923$$

Where y = Magnification

x = Time intervals

Table 8: Depicting crestal bone level measured by radiograph at various time intervals.

Factor	Parameter	IMPLANT PLACED	1st MONTH	3rd MONTH (IMPLANT LOAD)	4th MONTH	6th MONTH
RADIOGRAHIC CRESTAL BONE LEVEL(mm)	Mean	11.61	11.28	11.13	10.95	10.88
	SD	2.22	2.26	2.23	2.24	2.15
	Min	8.30	8.00	7.80	7.70	7.80
	Max	14.80	14.70	14.30	14.20	14.10



Graph 5: Representing average crestal bone level measured by radiograph which is decreasing with time after the implant placed.

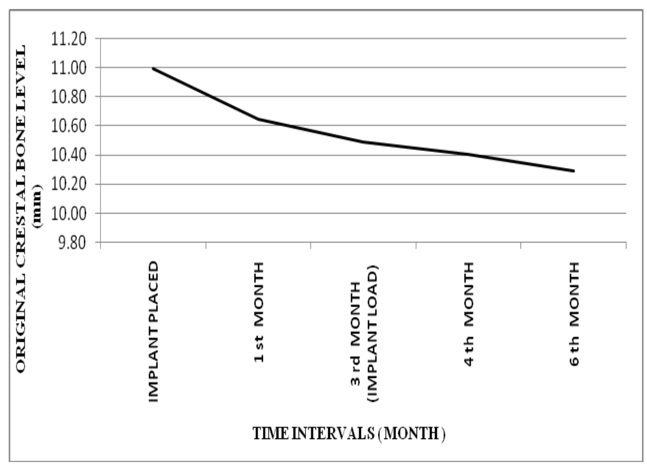
Table 9: Regression equations representing the relationship between crestal bone levels measured by radiograph with various time intervals.

Equation	R Square	Parameter Estimates			
		Constant	b1	b2	b3
Linear	0.893	11.493	-0.115		
Quadratic	0.960	11.566	-0.220	0.018	
Cubic	0.971	11.592	-0.333	0.068	-0.005

Here the quadratic equation (R^2=0.960) showing the relationship between the crestal bone level and different time intervals. This equation is given as follows $y = 0.018x^2 - 0.220x + 11.566$, Where y = Magnification and x = Time intervals

Table 10: Showing original crestal bone level at various time intervals.

Factor	Parameter	IMPLANT PLACED	1st MONTH	3rd MONTH (IMPLANT LOAD)	4th MONTH	6th MONTH
ORIGINAL CRESTAL BONE LEVEL(mm)	Mean	10.99	10.65	10.49	10.40	10.29
	SD	1.44	1.56	1.49	1.42	1.42
	Min	8.90	8.43	8.41	8.38	8.21
	Max	12.97	12.90	12.60	12.38	12.20



Graph 6: Representing average original crestal bone level which is decreasing with time after the implant placed.

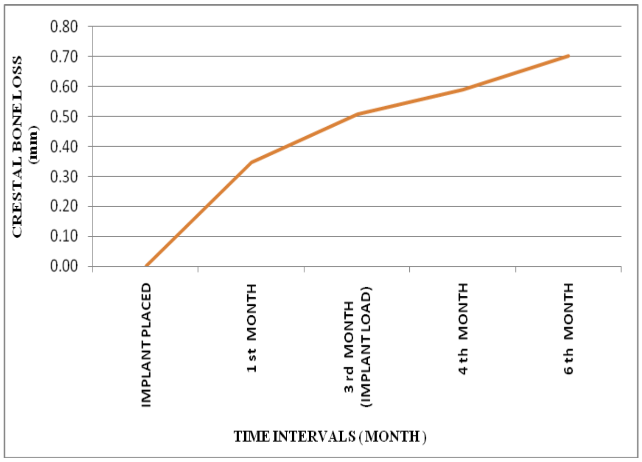
Table 11: Regression equation depicting the relationship between crestal bone levels with various time intervals.

Equation	R Square	Parameter Estimates			
		Constant	b1	b2	b3
Linear	0.878	10.863	-0.107		
Quadratic	0.956	10.936	-0.211	0.018	
Cubic	0.990	10.980	-0.400	0.102	-0.009

Here the cubic equation (R^2=0.990) showing the relationship between the crestal bone level and different time interval. This equation is given as follows $y = -0.009x^3 + 0.102x^2 - 0.400x + 10.980$, Where y = crestal bone level and x = Time intervals.

Table 12: Representing crestal bone loss at various time intervals.

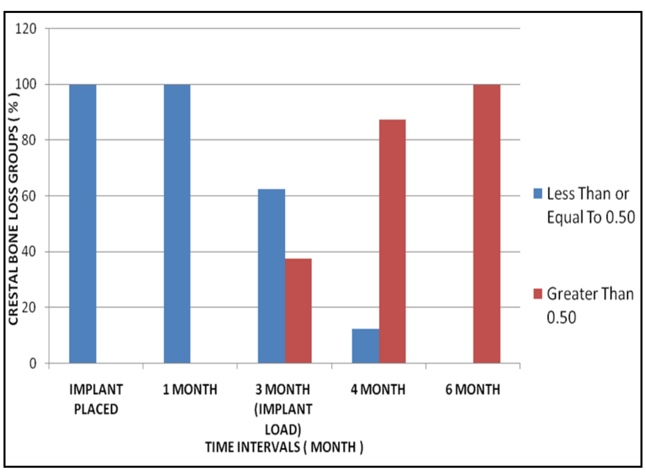
Factor	Parameter	IMPLANT PLACED	1st MONTH	3rd MONTH (IMPLANT LOAD)	4th MONTH	6th MONTH
CRESTAL BONE LOSS(mm)	Mean	0.00	0.35	0.51	0.59	0.70
	SD	0.00	0.16	0.11	0.08	0.06
	Min	0.00	0.07	0.37	0.46	0.62
	Max	0.00	0.50	0.70	0.70	0.78



Graph 7: Showing average crestal bone loss is increasing with time after the implant placed.

Table 13: Depicting percentage of crestal bone loss in all patients during observation at different stages (time).

BONE LOSS	IMPLANT PLACED	1st MONTH	3rd MONTH (IMPLANT LOAD)	4th MONTH	6th MONTH
Less Than or Equal To 0.50mm	8 patients	8 patients	5 patients	1 patient	0 patient
	100.00%	100.00%	62.50%	12.50%	0.00%
Greater Than 0.50mm	0 patient	0 patient	3 patients	7 patients	8 patients
	0.00%	0.00%	37.50%	87.50%	100.00%



Graph 8: Showing crestal bone loss percentage in patient at different time of observation.

Table 14: Regression equation representing the relationship between crestal bone loss with various time intervals.

Equation	R Square	Parameter Estimates			
		Constant	b1	b2	b3
Linear	0.867	0.133	0.106		
Quadratic	0.951	0.057	0.215	-0.018	
Cubic	0.991	0.009	0.418	-0.109	0.010

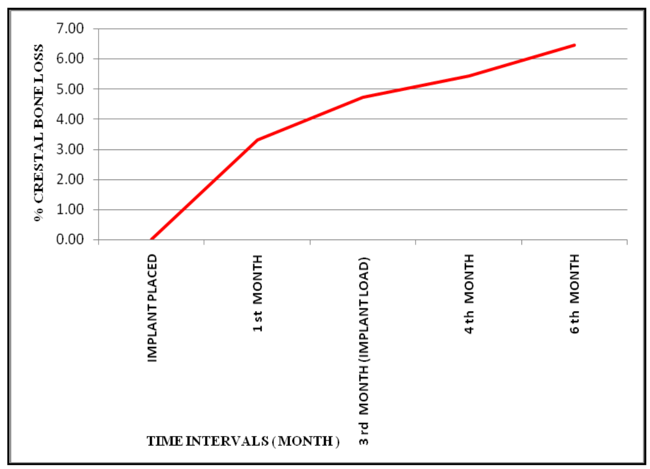
Here the cubic equation (R^2=0.991) showing the relationship between the crestal bone loss and different time intervals. This equation is given as follows

$$y = 0.010x^3 - 0.109x^2 + 0.418x + 0.009$$

Where y = crestal bone loss
x = Time intervals

Table 15: Showing percentage of crestal bone loss at various time intervals.

Factor	Parameter	IMPLANT PLACED	1st MONTH	3rd MONTH (IMPLANT LOAD)	4th MONTH	6th MONTH
% CRESTAL BONE LOSS	Mean	0.00	3.30	4.71	5.42	6.45
	SD	0.00	1.72	1.36	0.88	0.83
	Min	0.00	0.53	2.85	4.07	5.03
	Max	0.00	5.28	6.79	6.79	7.75



Graph 9: Representing percentage of crestal bone loss with time intervals.

Table 16: Regression equations showing the relationship between percent crestal bone loss with various time intervals.

Equation	R Square	Parameter Estimates			
		Constant	b1	b2	b3
Linear	0.860	1.256	0.971		
Quadratic	0.945	0.556	1.977	-0.171	
Cubic	0.990	0.086	3.968	-1.057	0.096

Here the cubic equation (R^2=0.990) showing the relationship between the percentage crestal bone loss and different time intervals. This equation is given as follows $y = 0.096x^3 - 1.057x^2 + 3.968x + 0.086$, Where y = % crestal bone loss and x = Time in month.

Discussion:

Loss of teeth is one of the major handicaps in elderly patients which compromise chewing efficiency and thus the nutritional status. Due to the early preventive strategies and increasing awareness, the prevalence of complete edentulism is declining worldwide especially in the developed countries. But in developing countries like India about 60-69% of populations are estimated to be either partially or completely edentulous over their 25th birthday. In an epidemiological survey conducted in 2012, it was revealed that a total of 62% of population was found to be completely edentulous of which, 30% in both arches, 19.2% in mandibular arch and 12.2% in maxillary arch.[25]

Dentures have been a source of compensation for edentulism, since time unknown, but the function and retention of dentures have always been a challenge for the dentist especially in the mandibular arch[25.] Rehabilitation using complete dentures on edentulous patients who suffer from a compromised alveolar bone often results in denture soreness, poor retention, instability, unclear pronunciation, and low chewing efficiency. Implant-retained overdentures are widely applied for the rehabilitation of edentulous jaws as it is able to increase retention rates of prosthesis, enhance the masticatory function and reduce the absorption of alveolar bone by regulating neuromuscular adaptation.[1]

Compared to the conventional complete denture, two or more implant-retained mandibular overdentures can promote function and enhance success rates. The York consensus statement recommends at least two implants to support mandibular overdentures for edentulous patients. However, economic constraints especially among the emerging elderly population in developing countries make this treatment strategy financially challenging. In order to reduce the cost and time of treatment, the concept of single implant-retained overdentures provides another option for elderly populations.[1]

Single implant retained overdentures have advantages over two implant retained overdentures. Two implant retained overdentures require the implant to be parallel to each other, be equidistant from the midline, at the same level, and failure of one may lead to unequal stresses on the other. These are avoided in case of a single implant retained overdentures.[2]

According to Tokuhisa et al the use of ball O-ring attachment could be advantages for implant supported overdentures with regard to optimizing stress and minimizing denture movement in comparison to bar attachment and magnets.[18]

The longevity of dental implants is highly dependent on integration between implant components and oral tissues, including hard and soft tissues. Initial breakdown of the implant-tissue interface generally begins at the crestal region in successfully osseointegrated endosseous implants.[3]

Many possible etiologies of early crestal bone loss around implants (from implant placement to 1-year post-loading) including surgical trauma, occlusal overload, peri-implantitis, the presence of microgap, reformation of biologic width, implant crest module, and others have been proposed. However, the location of dental implants, whether subcrestal or supracrestal, is still becoming increasing importance for researchers.[3]

Submerged titanium implants had 0.9 to 1.6 mm marginal bone loss from the first thread by the end of the first year in function, while only 0.05 to 0.13 mm bone loss occurred after the first year. Based on the findings on submerged implants, Albrektsson et al and Smith and Zarb proposed criteria for implant success, including a vertical bone loss of less than 0.2 mm annually following the implant's first year of function.[15]

F.Vafaee et al in their study found that marginal bone loss was 0.5mm at the end of 6 months in single implant retained mandibular overdenture.[18]

Gholami H et al described the importance of radiographs to assess implant success rate by evaluating and comparing crestal bone loss at different time intervals. But Serwin I reported that radiographic measurement of crestal bone loss by Intraoral Periapical (IOPA) radiographs are subject to change at each appointment. Previous studies like Ji-Hoon described a conventional technique to assess crestal bone changes by measuring the distance between the first screw thread of the endosseous implant to the top of the alveolar crest. The main disadvantage of this technique is to precisely measure crestal bone loss as the distance is very small to calculate between those two points.[24]

To minimize inconsistencies and measurement errors, Pravin Kumar G. Patil and Smita Nimbalkar proposed a method to measure the radiographic crestal bone level from the tip of the implant body to the top of the alveolar crest instead of the first thread of the implant to the alveolar crest. As the distance between the first thread and alveolar crest was much less and could not be measured precisely[24]

Method used for calculating crestal bone level at particular time will be given by,Original crestal bone level at baseline = (radiographic crestal bone level × original or physical length of the implant body) / radiographic length of the implant body[24] and the method used for calculating crestal bone loss is, Crestal bone change or loss (at given time) = original crestal bone level at baseline – crestal bone level at that particular time)[24]

In our study the mean crestal bone loss measured between the tip of the implant and alveolar crest was found to be 0.7mm at the end of 6 months after implant placement as depicted in table 12. Graph 6 shows that original crestal bone level was decreasing with time. Graph 7 depicts average crestal bone loss was increasing with time after implant placement. Percentage crestal bone loss was increasing with time during a period of 6 month follow up period as shown in graph 9. Also mean percentage crestal bone loss was around 6.45% at the end of 6 months after implant placement.

Finding and observations of our study is in accordance with observations made by AJ. Flichy Fernandej et al which shows that after 6 months, bone loss was 0.80±1.04 mm on mesial side and 0.73±1.08 mm on distal side, while after 12 months bone loss was 0.92±1.02 mesially and 0.87±1.01 distally.[13] The observation made in the study by F.Vafaee et al which was 0.5mm at the end of 6 month is also comparable to finding of our study.[15]

The findings in the study of Guruprasad for crestal bone loss was 0.74mm which supports the finding of our study.[22] Observations of our study show significant correlation between crestal bone loss and time with p value of < 0.05.The scope of single implant retained overdentures can be a promising alternative for patients with an atrophic mandible, systemically compromised patients with financial difficulties which has been proven by finding of our study. We can conclude that the single implant supported overdentures is a good treatment option for severely resorbed, financially and systemically compromised completely edentulous patients of developing countries like us.

The limitation of this study was small sample size with short duration of 6months follow up period.

Conclusion:

The study results showed that the Radiographic measurement of crestal bone loss was subject to error in either shortening or elongation of the image. So magnification error formula was used for measuring the original crestal bone loss which is an important criteria for estimating the success criteria of endosseous dental implants to reduce the error. Taking into account the original crestal bone level as baseline for measuring and calculating crestal bone loss then it was found that mean rate of crestal bone loss with time was more during first month (0.35mm) then it decreased in 3rd month (0.51mm) and further decreased during 4th month (0.59mm) and 6th month (0.70mm) follow up period. The concept of single implant supported overdentures provides another option for completely edentulous elderly patients with severely resorbed mandibular ridge & with economic constraints in developing countries.

Future perspectives:

There is a need for further studies with more number of sample size and longer duration follow up, to confirm the results of this study for measuring and calculating crestal bone loss in single implant supported overdentures.

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