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Short Length Versus Conventional Implants in Rehabilitation of Completely Edentulous Mandible

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Abstract

Various bone augmentation strategies have been proposed to overcome the anatomic and physiologic limitations of implant placement in patients with atrophic edentulous ridges. The use of short implants may provide an alternative treatment to avoid complications associated with alveolar bone augmentation. However, the clinical effectiveness of short implants versus long implants was not thoroughly investigated. Marginal bone height changes around short and conventional implants were evaluated in this study

Methods: Fourteen completely edentulous male patients were selected and divided into two equal groups. Group (I) Patients received conventional complete maxillary dentures opposed by mandibular overdentures supported and retained by two conventional implants of 4mm diameter and 12mm length placed in the lateral-canine regions. Group (II) Patients received conventional complete maxillary dentures opposed by mandibular overdentures supported and retained by two short implants of 4mm diameter and 8mm length placed in the lateral-canine regions.

Results: The results of the present study revealed statistically insignificant difference in the calculated means of the measured peri-implant bone height changes between the two studied groups.

Conclusions: Placement of short implants may provide an effective option to rehabilitate edentulous patients whenever conventional implants cannot be placed without prior bone augmentation providing surgical advantages, reduced patient morbidity, treatment time and costs.

Key words:

Edentulism – Residual ridge augmentation - Implant retained mandibular overdenture – Short dental Implants - Marginal bone loss.

Introduction

The classical treatment plan for the edentulous patient is the complete removable maxillary and mandibular dentures. However, such prostheses, especially the mandibular denture, have well-documented problems such as lack of stability and retention. This can be affected by the height and shape of the mandibular ridge as continued loss of alveolar bone can occur over time, and cause previously stable dentures to become ill-fitting. (1)

Subsequent bone loss leads to a decrease in the size of the denture bearing area, thereby reducing denture stability which causes insufficient retention of the lower denture, difficulties with eating and speech and altered facial appearance, in some cases, people avoid social situations completely. (2)

The advent of osseo-integrated dental implants with implant-supported or retained mandibular overdentures provide superior alternative to the essentially palliative therapy offered by conventional dentures. (3)

various strategies have been proposed to overcome the anatomic and physiologic limitations of implant placement. Surgical protocols employing bone grafting, inferior alveolar nerve transposition, distraction osteogenesis and sinus augmentation have been suggested for standard implants rehabilitation treatments, while these methods have obtained a level of success, many patients are unable or unwilling to undergo such surgical procedures due to high cost, the need for multiple surgeries and poor general health. (4)

The use of short implants has been discouraged from a biomechanical point of view, when combined with poor bone quality and high occlusal loads. However, the development of implant design, surface structure, and improved surgical technique has given reason to re-evaluate previous results where recent clinical studies indicated that short implants may present results similar to those of longer implants in clinical situations with little bone availability providing a less complex, less traumatic and more safe treatment alternative (5)

Several studies have demonstrated that short dental implants could be used successfully. However, the clinical effectiveness of short implants versus long implants was not thoroughly investigated. (6)

Materials and Methods

Patient Selection:

- Fourteen completely edentulous male patients were selected from those attending the out-patient clinic of Removable Prosthodontics Department, Faculty of Dentistry-Ain Shams University to participate in the study.

Inclusion Criteria:

- Patient's age ranged from 55 - 65 years with mean age of 60 years old.
- Patients had completely edentulous maxillary and mandibular arches.
- Patients were medically free from any neurologic disorder that might affect the neuro-muscular system or any systemic disease that might affect bone metabolism or delay post-operative healing.
- Only patients with good oral hygiene were enrolled in the study.
- Patients with Angle Class-I maxillo-mandibular relationship and sufficient inter-arch spaces were selected.
- Residual alveolar ridges were covered with firm healthy mucosa, free from any signs of inflammation, ulceration or flabbiness.
- Patients with at least 1 year elapsed after last teeth extractions were enrolled in the study.

Exclusion Criteria:

- Patients with Systemic diseases that might affect bone quality, contribute to bone resorption, increase surgical risk, delay or complicate post-operative healing were excluded.
- Patients with contraindications for surgical procedures or patients with parafunctional habits were excluded.
- Patients with pathological lesions, mandibular tori or bony exostoses that might complicate complete denture construction and/or implant placement were excluded.
- Patients with any muscular or TMJ disorders were excluded.
- Patients with severe cardiovascular diseases, metabolic disorders, history of previous radiotherapy and chemotherapy, osteoporosis, allergies and impaired psychological conditions were excluded. Also smoking patients were excluded.

Prosthetic Procedure

Primary impressions were made using irreversible hydrocolloid impression material (Cavex Holland B.V., P.O. Box 852-2006 RW Haarlem, Holland) in properly selected and modified stock trays and poured in dental stone to obtain study casts.

Occlusion blocks were constructed on the study casts, diagnostic wax wafer jaw relation records were made at proper vertical and horizontal relations, then the casts were mounted on a fixed condylar path articulator (ASA Dental S.P.A. #5000 Fixed Condylar Path Articulator Italy). Trial set-up of artificial teeth was carried out on the mounted diagnostic casts to evaluate the ridge relationship, the available inter-arch space and to ensure the presence of 10-12mm of vertical space for the lower denture.

Custom made auto-polymerized acrylic resin (Pekatray, Bayer Dental, Leverkusen, Germany) trays were fabricated on the study casts then border tracing was made with vinyl Polysiloxane putty consistency impression material (3M ESPE Putty-Vinyl Polysiloxane 2510 Conway Avenue St. Paul, MN55144-1000 USA) and final wash impressions were made using Vinyl Polysiloxane light body impression material (3M ESPE Light Body-Vinyl Polysiloxane 2510 Conway Avenue St. Paul, MN55144-1000 USA).

Master casts were obtained by pouring the secondary impressions into dental stone. Upper and lower occlusion blocks were constructed on the master casts. Maxillary face bow (Hanau spring Bow-Whip Mix Corporation 361 Farmington Avenue Louisville, KY 40209) record was made to mount the maxillary master cast on a semi-adjustable articulator. (Hanau model H semi-adjustable articulator Whip Mix Corporation 361 Farmington Avenue Louisville, KY USA 40209).

Centric occluding relation was made using wax wafer method at the proper vertical dimension of occlusion to mount the lower master cast. Protrusive jaw relation records were made to Calibrate the Horizontal Condylar Path (H) on the articulator and the incisal guidance was calibrated accordingly. Lateral Condylar Path (L) was calibrated on the articulator according to Hanau formula: (L=H/8+12). and the incisal guidance was calibrated accordingly.

Modified cross-linked acrylic teeth (Vita-pan acrylic teeth, Vita Ban Sackingen- Germany) were modified and arranged following the lingualized concept of occlusion. The waxed up dentures were tried in the patient's mouth to ensure proper facial contour, aesthetic, even contact between all the posterior teeth and harmony between centric occlusion and centric relation at the predetermined vertical dimension of occlusion. A plaster index was made for the maxillary waxed up trial denture base on the semi adjustable articulator for clinical remounting procedure.

The waxed-up dentures were flasked and processed into heat cured acrylic resin (Acrostone Heat-Cured, Acrostone Dental factory, Egypt, under Exclusive License from WHW, England). Laboratory remounting was done before decasting of the dentures and occlusal discrepancies were adjusted. Dentures were finished, polished then soaked in water for 24 hours till delivered.

For clinical remounting, the maxillary remount cast with the denture were mounted on the articulator with the aid of the plaster index, while the mandibular remount cast was mounted on the articulator by new centric relation record.

Post insertion instructions were given to the patient. Patients were instructed to follow meticulous oral hygiene measures by cleaning the denture polished and fitting surfaces with a soft brush, rinsing with Chlorohexidine mouth wash while the prosthesis out of the oral cavity, remove the dentures during sleeping hours, avoid using house hold bleaches for cleaning the dentures and keeping the dentures in tap water when not in use.

Patients were recalled after 24 hours, 3 days and one week to perform any needed adjustments.
Two weeks later occlusal adjustment was carried out to eliminate occlusal interference and provide free gliding from centric to eccentric positions.

The final processed mandibular dentures were duplicated into a clear acrylic resin (Acrostone, Dental Factory-industrial zone, Salam city A.R.E.-WHW Plastis England) templates to produce a radiographic stent. The stent with the radiographic markers was positioned in patient's mouth during the radiographic evaluation.

Cone Beam Computed Tomography (CBCT) was made to evaluate bone height, width and density in the proposed implant sites. (Figure.1)

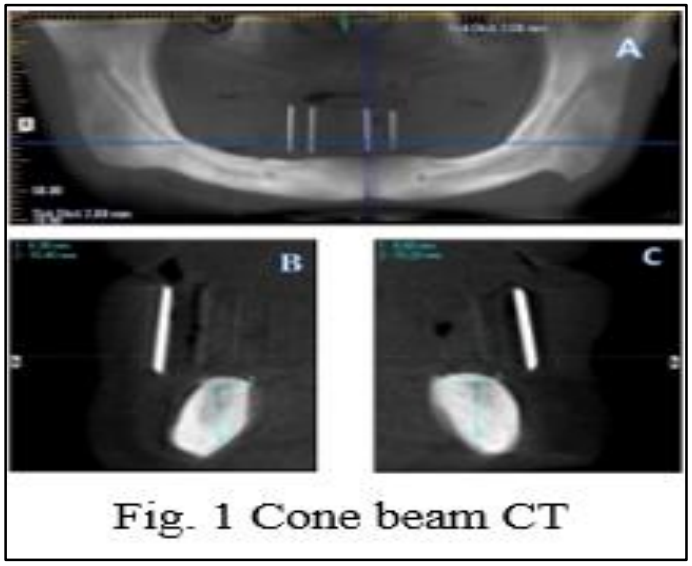

Fig. 1 Cone beam CT

Patient Grouping:

Based on cone beam computed tomographic assessment Selected patients were equally divided into two groups: -

Group (I): Patients received conventional complete maxillary dentures opposed by mandibular overdentures supported and retained by two conventional implants of 4mm diameter and 12mm length placed in the lateral-canine regions.

Group (II): Patients received conventional complete maxillary dentures opposed by mandibular overdentures supported and retained by two short implants of 4mm diameter and 8mm length placed in the lateral-canine regions.

Surgical Procedures:

Patients were asked to rinse the oral cavity with chlorohexidine-gluconate for 1 minute prior to the surgery and the peri-oral region of the patient's face was wiped with Betadine antiseptic solution. Bilateral nerve block and field block anesthesia were administered (Ubistesin Forte – AUST R 165574. 3M Australia Pty Ltd Building A, 1 Rivett Road North Ryde, Nsw 2113). After the anesthetic effect was confirmed the surgical stent was properly seated in position in the patient's mouth and a dental probe was inserted into the notches made in the stent to puncture the mucosa covering the alveolar ridge. These punctures represented the sites of implant insertion which appeared as bleeding points and the flap area was identified.

Using bard-parker blade No. 15, two mid crestal incisions in the lateral-canine areas extending 2mm mesially and distally without crossing the midline were made at the proposed implant sites with relaxing incision extending labially from the crest of the ridge to the depth of the vestibule

A full thickness mucoperiosteal flap was reflected using a sharp mucoperiosteal elevator. The lingual mucoperiosteum was also slightly dissected. Irregularities on the crest of the ridge were smoothened using bone file.

The surgical stent was seated in the patient's mouth and under copious saline irrigation, drilling started with point drill with light intermittent finger pressure and at speed of 1000 rpm and 30 N/cm torque for marking the insertion point of the implant on the alveolar ridge.

Initial Drill of 2.2mm diameter was used for stepped osteotomy site preparation. to provide a stepped guiding pathway for the 4mm diameter fixture final drill. Depth Gauge with scaled rod was then used for measuring the drill depth. Parallel Pins were used to check the osteotomy path. Final Drill of 4mm diameter was used to prepare the final depth and alignment of the implant site.

Fixture driver was then used to remove the fixture from its sterile package and to install the fixture in the osteotomy site. The implant was threaded into the bone in a clockwise direction under saline irrigation until its top flushed with the bone surface using the torque wrench and Hex driver was used to tighten the covering screws over the implants. The mucoperiosteal flaps were repositioned and sutured with 3-0 black silk interrupted sutures. Following surgery; post-operative panoramic radiograph (Figure.2) was made to confirm accurate implant installation in the proposed sites.

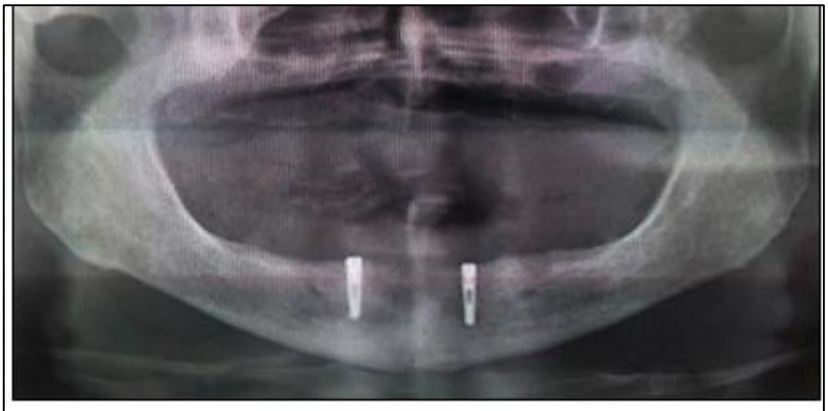

Fig2: Post-operative panoramic radiograph.

Patients were recalled after three months Fixture position was detected by sterile explorer and the surgical stent was used as a guide for implant position. Local anaesthesia was infiltrated at the implant site, and a sterile punch was used to expose the implant.

Using a hex driver, the covering screws were unthreaded, chlorohexidine solution was used to irrigate internal implant structure and then using a ball abutment driver and torque wrench the ball abutments were screwed in position with connecting torque force of 30N/cm. (Figure.3)

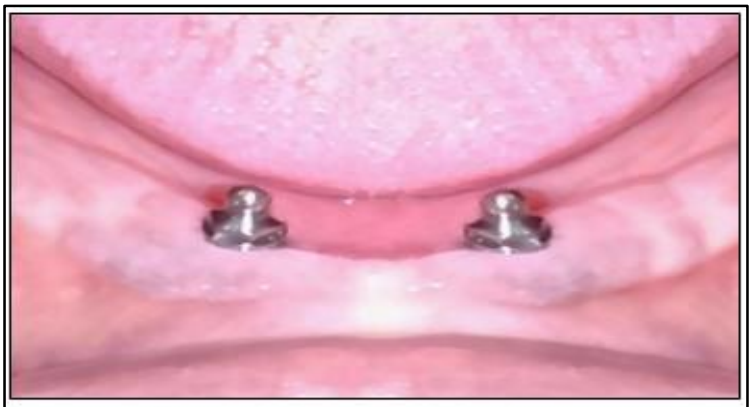

Fig.3: Ball Abutments Installation

Pick-up procedure:

Prior to the pick-up of the metal housings, block-out shim was adapted to each abutment to block out the undercut areas (dead-space) inferior to the ball abutments (sub-housing area), then the metal housings were placed in position.

Hard denture lining material (GC Hard Denture Liner, GC America INC. ALSIP, IL 60803 U.S.A.) was used for chair-side pick-up of the metal housings.

With the maxillary denture in place the patient was guided to close in centric occluding relation till complete curing of the hard denture liner occurred. After complete setting of the hard denture lining material the mandibular denture was removed, checked for areas of excess material which were trimmed carefully relieving any contact to the gingival margins, then smoothened and polished. The mandibular overdenture was inserted again intra-orally and checked for proper occlusion and orientation in relation to the maxillary denture.

Radiographic Evaluation:

All patients were scheduled for follow up visits to evaluate marginal bone height changes at the Mesial (M), Distal (D), Buccal (B), and lingual (L) sites of each implant using cone beam computed tomography (i-CAT Next Generation; Imaging Sciences International LLC.1910 North Penn Road Hatfield, PA.19440. USA.) CBCT records were obtained upon Overdenture Insertion (Baseline), Six Months, Twelve Months and Eighteen Months after insertion.

Patients were instructed to remove their dentures before entering in the cone beam machine. The patients were seated in upright position in the middle of the chair with their backs pushed against the backrest and their heads resting on the head support. The scan parameters were 120 kVp, 5 mA, voxel size of 0.25 mm, exposure time of 7 seconds, field of view 6 cm high x 16 cm wide. The patients were instructed not to move during the duration of the exposure. After exposure, the 3D image appeared on the computer screen display, the head support was opened and the patients were guided out of the unit.

Image Analysis:

The Mesial, Distal, Buccal and Lingual marginal bone heights around the implants were evaluated, using the linear measurement system of the software (i-CAT Vision; version1.9.3.13; Imaging Sciences International LLC.1910 North Penn Road Hatfield, PA.19440. USA.)

From the axial plane, horizontal (X and Y) axes at a right angle to the long axis of each implant were reconstructed to give two vertical cross-sectional images as follows: Mesio-Distal (MD) image, formed by axis that bisected the alveolar ridge and the implants Mesio-Distally and Bucco-Lingual (BL) image, formed by the axis that bisected the implant Bucco-Lingually. This resulted in four circumferential measurements: Mesial (M), Distal (D), Buccal (B) and lingual (L).

From the sagittal plane, the mesial and distal marginal bone heights around implants were evaluated. First a line was drawn horizontally tangential to the apex of the implant and perpendicular to its long axis. Three lines were then drawn tangential to the mesial surface of the implant, parallel to each other and extending from the highest level of alveolar crest to the horizontal line. The sum of lengths of three lines was obtained and divided by three to obtain the average of bone height. The same procedure was repeated for the distal surface of the implant. Also from the coronal plane, the buccal and lingual marginal bone height of the implants were evaluated with the same procedure. (Figure.4)

The measurements were carried out at the end of each follow up appointment: Overdenture Insertion (Baseline), Six Months, Twelve Months and Eighteen Months after insertion. The marginal bone loss at different intervals was obtained by calculating the difference in bone height at that interval from the base line measurements.

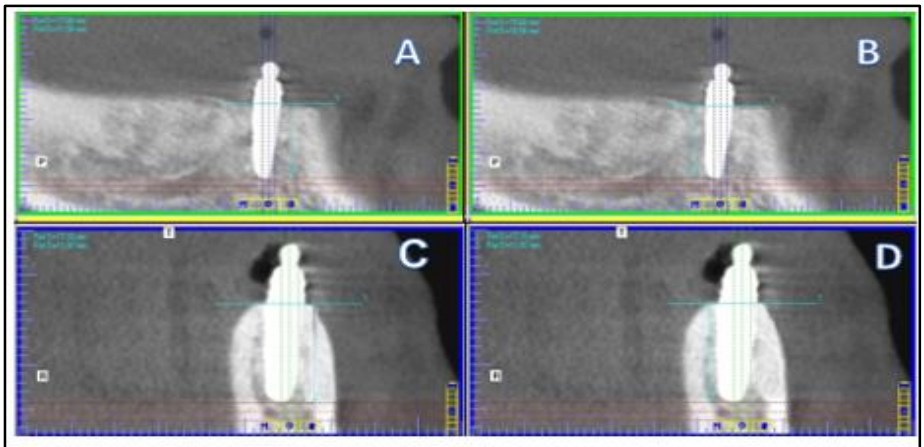

Fig.4 Bone height measurements. (A)mesial bone height in sagittal plane. (B) distal bone height in sagittal plane. (C) Buccal Bone height coronal plane. (D) Lingual bone height in coronal plane

Statistical Analysis

Numerical data were explored for normality by checking the data distribution, calculating the mean and median values, evaluating histograms and normality curves and using Kolmogorov-Smirnov and Shapiro-Wilk tests.

Data were presented by mean, standard deviation (SD). Independent Student t-test was used for comparison between groups. ANOVA for repeated measures was used for comparison between follow up periods followed by simple main effect. The significance level was set at $P \leq 0.05$. Statistical analysis was performed with IBM SPSS (SPSS Inc., IBM Corporation, NY, USA) Statistics Version 20 for Windows. The study results are presented in (Figure 5)

Results

At six-month interval, the calculated means of the measured bone loss for all surfaces in Group (I) and Group (II) Patients revealed a total change of 0.53 ± 0.08 mm and 0.58 ± 0.05 mm respectively. The difference in the calculated means of the measured bone loss between both groups was statistically insignificant at $P > 0.05$.

At twelve-month interval, the calculated means of the measured bone loss for all surfaces in Group (I) and Group (II) Patients revealed a total change of 0.68 ± 0.07 mm and 0.73 ± 0.06 mm respectively. The difference in the calculated means of the measured bone loss between both groups was statistically insignificant at $P > 0.05$.

At eighteen-month interval, the calculated means of the measured bone loss for all surfaces in Group (I) and Group (II) Patients revealed a total change of 0.78 ± 0.07 mm and 0.83 ± 0.06 mm respectively. The difference in the calculated means of the measured bone loss between both groups was statistically insignificant at $P > 0.05$.

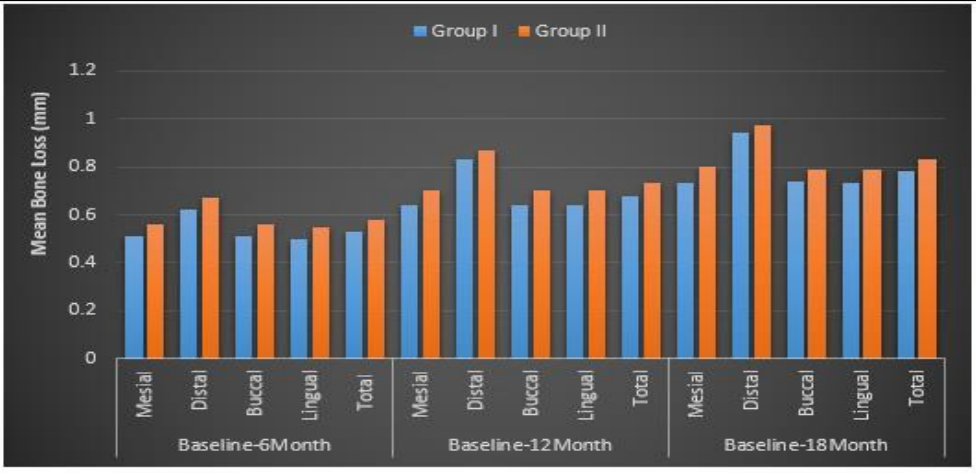

Fig. (5): Bar Chart Representing Mean Amounts of Bone Loss in the Two Studied Groups.

Discussion:

The outcomes of long-term clinical studies using a delayed loading protocol implies successful osseointegration. Accordingly, three months healing period was allowed after fixture installation. [7] A two stage surgery is advocated for short implants as it provides proper implant stabilization during healing phase. [8]

All implants used in the current study for both groups revealed successful osseointegration throughout the follow up period as manifested by (1) absence of subjective complaints such as pain, dysesthesia, or paraesthesia at the implant sites, (2) absence of recurring peri-implant infection and/or suppuration, (3) absence of perceptible implant mobility and (4) absence of radiolucencies at the implant-bone interface. Furthermore, all implants used in the study for both groups revealed less than 1mm of vertical bone loss during the first year till the end of follow up period. The above mentioned findings are fully consistent with implant success criteria proposed by Buser et al. [9], Smith & Zarb [10], Albrektsson and Zarb et al. [11]

It has been observed that the maximum calculated mean of marginal bone loss for both groups was evident at the six-month interval and progressed slowly thereafter. According to Cochran et al. [12], peri-implant bone remodeling after implant placement is more accentuated in the first 6 months after surgery. The authors found 86% of the bone loss to take place in the first 6 months after loading. Other investigators such as Lee et al. [13], and Hartman et al, [14] likewise consider most bone loss to occur in the first 6 months, followed by gradual stabilization till the end of follow up period.

This bone loss could be based on the hypothesis that marginal bone loss is the result of micro-damage accumulation occurring in bone after implant placement. It was also explained as an early manifestation of wound healing which occurs after implant placement and as a reaction to loading. [15] Crestal bone loss could also be explained by the finding that forces applied on implants are distributed on the crestal bone rather than along the entire implant/bone interface. [16, 17]

It was observed that the maximum calculated mean of marginal bone loss occurred at the distal surface for Group I and Group II patients at all intervals of the follow up period. This may be attributed to The resiliency of ball attachments that allowed load sharing between the implants and the edentulous ridge. These findings are consistent with Dominici et al. [18], Petropoulos et al. [19], Kenney and Richards [20], Burns DR. [21] and Mazaro et al. [22] where more bone loss has been reported distally due to bone strain at these sites relative to the length of the edentulous area.

It was observed that throughout the follow up period the difference in calculated means of the measured bone loss for all surfaces and at all intervals between Group (I) and Group (II) Patients was statistically insignificant. These findings are consistent with a prospective study by Nedir et al [23] who have reported that 8-9 mm sandblasted large grit acid etched implants showed high cumulative success rates as high as 12-13mm implants. Furthermore, the data obtained in the current study fully comply with systematic reviews by Lee et al [24] Srinivasan et al [25], Atieh et al., [26] Telleman et al., [27] Monje et al., [28] Draenert et al., [29] and Karthikeyan et al. [30] that evaluated the marginal bone loss and survival rates of short dental implants overall concluding that survival rates of short dental implants are similar to long implants.

Conclusions:

Placement of short implants may provide an effective option to rehabilitate edentulous patients whenever conventional implants cannot be placed without prior bone augmentation providing surgical advantages, reduced patient morbidity, treatment time and costs.

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