

Mini-Implant Overdenture Versus Conventional Implant Overdenture (A Radiographic and Clinical Assessments)

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Abstract: Nowadays mini-implant overdenture is widely used as a substitution for the conventional two-implant overdenture. More studies and assessments are needed to confirm this replacement. Thus, fourteen male patients were selected then categorized randomly into two groups. The first group received seven mandibular mini-implant overdentures retained by four single piece mini-implants. The second group received seven mandibular overdenture retained by two conventional size implant assembled with ball attachment. All patients were scheduled for recall visits at time of loading, six months and twelve months to measure marginal bone height, probing depth and gingival index. At six month, the first group showed higher mean values of both marginal bone height (0.758 ± 0.141 mm) and probing depth (2.297 ± 0.198 mm) than the second group with statistically significant difference at $p < 0.05$. At twelve month, the first group showed higher mean value also for marginal bone height (2.938 ± 0.176 mm) with statistically significant difference at $p < 0.05$. The mean value of the pocket depth of the first group (2.896 ± 0.140 mm) was higher than the second group with no statistical significance. Gingival index results showed a slight change between the two groups with no statistically significant difference. Although mini-implant overdenture is a successful treatment option for completely edentulous patients, the conventional two-implant overdenture showed advantageous radiographic and clinical outcomes.

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1. Introduction

Mini-implant is potentially one of the solutions to the affordability dilemma of replacing missing teeth with conventional implants. It is less invasive, and technically easier than conventional implants. These narrow implants were often used where there is no enough bone thickness for conventional implants or to temporarily stabilize a denture while conventional implants heal (Labarre et al., 2008) and (Konvic et al., 2004). It also represents a very efficient solution for denture wearers who have experienced extreme discomfort due to loose and ill-fitting dentures where problems associated with trapped food particles, denture breath and social issues are virtually eliminated (Akpinar et al., 1996).

In the last few years mini-implants became widely used as an orthodontic anchorage, single and multiple tooth fixed replacement, bridge repair and removable prosthesis retention, where they became a key solution for many challenging situations (Bryant et al., 2007) and (Shawnee, 2008). Further, the evolution of the dental implantology science generates technological breakthroughs in the mini-implant design. This development includes enhancement of the implant shape, thread patterns and its surface treatments, which have considerably

improve primary stability and lead to faster osseointegration (Jones and Cochran, 2006) and (Sakoh et al., 2006).

Implant size influences the area of possible retention in bones. Additionally, factors such as occlusion, masticatory forces, number of implants and their position within the prosthesis affect the forces acting on the bone adjacent to the implants (Christensen, 2006) and (Froum et al., 2005). Holmgren et al., (1998) added that load direction in addition to implant diameter and shape influence stress distribution.

Furthermore, Jefferies et al., (2008) studied the detachment retentive forces of both conventional and mini-implants by evaluating their detachment speed. However, the values were not indicative whereas the detachment force showed some relevance in certain speeds.

Ahn et al., (2004) investigated mini-implants as retentive aid for overdenture. Their study revealed a high success rate and a favorable prosthetic outcome that augment their use in edentulous arches. They also emphasized that mini-implant could be a good solution for those patients suffering from discomfort and less functional dentures.

Mini dental implants have many benefits such as expanding the bone as they are placed, minimal osteotomy size required as well as immediate stabilization and loading on the day of placement and so fewer treatment visits (Balkin et al., 2001). Moreover, flapless placement leads to minimal surgical trauma, easier removal and healing in case of failure. Their cost is also significantly less than conventional implants (Zahran, 2008).

Several researches showed the success of mini-implant overdentures, however long term evaluation is lacking (Sohrabi et al., 2012), (Al-Nawas et al., 2012), (Canizales, 2011), (Dang, 2011) and (Šćepanović et al., 2012). More studies need to be carried out to provide additional rigorous scientific evidence to support this therapeutic paradigm. Away from the rush of using and deliberating these implants as a substitution for conventional implants, further studies should be carried out to accredit this substitution.

The purpose of this study was to compare both radiographically and clinically the use of mini-implant overdenture to the conventional two-implant overdenture as treatment modalities.

2. Material and Methods

A total of fourteen completely edentulous male patients were included in this study from the outpatient clinic, College of Dentistry, Qassim University, KSA, with an average age of 55 years. The selection criteria were based on the validity of these patients to receive implant-tissue supported overdenture (Misch, 2008). Patients should be free from any medical conditions that might interfere with implant placement and/or osseointegration. They all should be non-smokers and did not receive any radio or chemotherapy treatment at any time. In addition, patients should have enough bone volume without the need to use any bone grafts. Radiographic assessment by panoramic x rays was done to confirm the amount of residual tissues.

The fourteen patients were randomly categorized into two groups. The first group (Group I) included seven patients treated with four mini-implants mandibular overdentures opposing a maxillary complete denture. The second group (Group II) included seven patients treated with mandibular overdentures retained by two ball attachments carried on two normal-sized implants.

All patients were scheduled to receive complete dentures before surgical procedure. The lower dentures were modified in thickness (6 mm thickness) at the lingual flanges during waxing-up at the proposed implants sites. Surgical templates were constructed for all patients by duplicating the finished lower dentures. Holes were drilled at the chosen implants sites to guide implant placement process.

Four mandibular mini dental implants (Sendax MDI MAX; IMTEC, Corp., Ardmore, USA), with a standard diameter of 1.8 mm, and a length 15 mm, were placed in each of the seven completely edentulous patients following immediate loading protocol.

Implant site planning was performed according to specific surgical and prosthetic considerations including; implants placement starting with a minimum of 5 mm anterior of the mental foramen, and a minimum of 5 mm was left between each implant to allow space for the housings. Subsequently, these positions were transferred to the gingiva and marked with bleeding points.

Drilling was started in a pumping action using the pilot drill (1.1 mm diameter) under profuse sterile irrigation. Once crestal cortical bone was perforated, drilling continued to about 1/3 to 3/4 implant length according to bone drilling resistance. The implant was removed from the sterile vial and the tip of the implant was placed with clockwise direction into the drilled site, using the implant mount cap as initial driver. Once the bone has engaged a resistance, the cap was discarded. The winged thumb driver was then used followed by torque ratchet wrench to seat the implant into its final seating position at 35 N/cm pre-customized torque (Fig. 1).

The included PVC tube was cut and slipped around the necks of the implants below the level of the O-ring. The metal housings were loaded with the rubber rings and then seated over the implant balls. The fitting surface of the denture was then relieved at the implants sites to create sufficient room for metallic housing. After painting the acrylic resin adhesive to the areas of the holes, the cold cured acrylic hard liner (Hardliner CD, Promedica Co., Germany) was injected in the relieved holes then seated in the patient mouth with a normal occlusal pressure. After 5 minutes, the denture was removed to trim excess material followed by PVC tubes removal (Fig. 2). Occlusion was rechecked after final setting of the added resin.



Figure 1: implants in position before pick-up procedures.



Figure 2: denture after pick-up of the metal housings of the mini-implant.

Two normal sized tapered internal implants (Tapered Internal dental implant system, Biohorizons Co., USA) were placed in each of the seven completely edentulous patients following early loading protocol (6 weeks postoperative). Implant site planning was intended for all anterior parasympheseal areas. A subcrestal incision was performed in the parasympheseal zone followed by osteotomy procedures. Drilling sequence started under profuse sterile irrigation by pilot drills (2, 2.5 mm diameters) followed by width increasing drills sequence to (3.7 mm) diameter drill. Bone tap drill was used whenever required to allow for final seating at 30-rpm speed. The implant was then inserted in the prepared osteotomy site, by applying firm apical pressure then rotating slowly (30 rpm) using hand piece driver. The cover screw was tightened over the implant fixture. The flap was then reassembled and stitched. Reliefs of the mandibular dentures were performed. Patients were then left for six weeks for healing and they were instructed to eat soft diet food. Healing abutments were placed for ten days, after which loading was performed (Fig. 3). The patients were then scheduled for complete dentures with enough lingual flange thickness at the implanted areas. The healing abutments were removed and replaced with the ball-shaped abutments, (Fig. 4).



Figure 3: implants with healing abutments in place during soft tissue healing.



Figure 4: ball abutments placed in the patient mouth after removal of the healing abutments.

The protective disc supplied with the prosthetic kit was placed around the implant neck below the O-ring position. The rubber O-ring was then loaded in the metallic encapsulator then placed on the implant ball. The mandibular dentures were relieved at the fitting surface opposing to the encapsulator positions until provide enough room for them. The encapsulators were then picked-up following pick-up technique, (Fig. 5).



Figure 5: lower denture with metallic encapsulator with loaded rubber rings after pick-up procedure.

All patients were scheduled for monthly recall visits to check out the overdenture, the implant and to perform oral hygiene measures if needed.

All patients were followed up at baseline (during loading visit), 6 and 12 months of loading, both clinically and radiographically.

I. Clinical evaluation

- Gingival Index (GI)

To assess potential peri-implant inflammation, the gingival index was used according to the modified Loe and Silness index (Loe and Silness, 1963). It was performed by careful isolation and drying the area around the implants. Each surface was scored individually according to the modified Loe gingival index (score 0: normal peri-implant mucosa; score 1: mild inflammation, slight change in color, and slight edema; score 2: moderate inflammation, redness, edema, and glazing; score 3: severe inflammation, marked redness and edema, and ulceration) and the mean value of the scored surfaces for each implant was calculated.

- Probing Depth (PD)

Using a graduated pressure sensitive probe (Vivacare TPS, Vivadent, Schaan, Lichtenstein) all the probing depth at the mid-buccal, mid-lingual, mid-mesial and mid-distal surfaces of the implants were measured and the mean value for the scored surfaces for each implant was calculated.

II. Radiographic evaluation

Radiographic periapical x-ray (Kodak, Rochester, NY, USA) was taken at as baseline (during loading visit), 6 months and 12 months of loading. Marginal bone height changes measurements were performed blindly by an independent investigator who did not informed about product informations.

- Bone height changes

A reference point was registered on the implant surface on the x ray image. The distance between the highest point of the bone at the implant-bone interface to the point of the selected reference point was measured digitally on both sides (mesial and distal) by Kodak software (Kodak, Dental Imaging Software 6, Eastman Kodak Co., USA) (Fig. 6). The mean value was then calculated for each patient.

Data were presented as mean and standard deviation (SD) values. Levene's test was used for equality of variances then Independent Paired t-test was used to study the changes along time within each group using (SPSS for Windows, version 14) at significance level ($p < 0.05$).

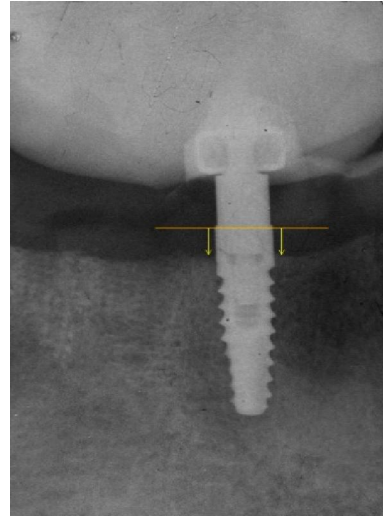


Figure 6: distance from marginal bone level to the set reference point was measured mesially and distally.

3. Results

After loading, the patients were scheduled for data collections, at baseline (during loading visit), 6 and 12 months of loading. Each implant had three data parameters to be evaluated (marginal bone height level, pocket depth and gingival index values). The data were tabulated then statistically analyzed.

Marginal Bone Height

After six months of loading, the mean value of the marginal bone height of group I ($0.758 \text{ mm} \pm 0.141 \text{ mm}$) was higher than group II ($0.652 \text{ mm} \pm 0.126 \text{ mm}$) with statistically significant difference at $p < 0.05$, (Table 1 and Fig. 7).

Table 1: mean, standard deviation and t-value of marginal bone height changes in (mm) of both groups at 6 month.

	Groups	Mean	Std. Deviation	t(p)
Marginal bone height 6 month	Group I (N=28)	0.758	0.141	2.381 (0.022)*
	Group II (N=14)	0.652	0.126	

t: for independent t-test

*: significant at $p < 0.05$

After twelve months of loading, the mean value of the marginal bone height of group I ($1.023 \text{ mm} \pm 0.122 \text{ mm}$) was higher than group II ($0.936 \text{ mm} \pm 0.099 \text{ mm}$) with statistically significant difference at $p < 0.05$, (Table 2 and Fig. 7).

Pocket depth

After six months of loading, the mean value of the pocket depth of group I ($2.297 \text{ mm} \pm 0.198 \text{ mm}$) was higher than group II ($2.163 \text{ mm} \pm 0.103 \text{ mm}$) with statistically significant difference at $p < 0.05$, (Table 3 and Fig. 8).

Table 2: mean, standard deviation (mm) and t-value of marginal bone height changes in mm of both groups at 12 months.

	Groups	Mean	Std. Deviation	t(p)
Marginal bone height 12 month	Group I (N=28)	1.023	0.122	2.323 (0.025)*
	Group II (N=14)	0.936	0.099	

t: for independent t-test
*: significant at p<0.05

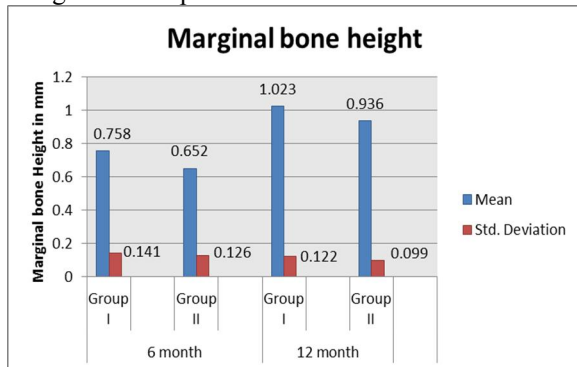


Figure 7: mean and standard deviation of marginal bone height changes in mm for both groups at 6 and 12 months.

Table 3: mean, standard deviation and t-value of pocket depth in (mm) at 6 month of both groups

	Groups	Mean	Std. Deviation	t(p)
Pocket depth 6 month	Group I (N=28)	2.297	0.198	2.383 (0.022)*
	Group II (N=14)	2.163	0.103	

t: for independent t-test
*: significant at p<0.05

After twelve months of loading, the mean value of the pocket depth of group I was (2.938 mm ± 0.176 mm) while group II was (2.896 mm ± 0.140 mm) with statistically non-significant difference at p<0.05, (Table 4, Fig. 8).

Table 4: mean, standard deviation and t-value of pocket depth in (mm) at 12 month of both groups.

	Groups	Mean	Std. Deviation	t(p)
Pocket depth 12 month	Group I (N=28)	2.938	0.176	0.761 (0.451)
	Group II (N=14)	2.896	0.140	

t: for independent t-test
*: significant at p<0.05

Gingival index

After six months of loading, the mean value of the gingival index of group I (0.637 mm ± 0.536 mm) was higher than group II (0.654 mm ± 0.482

mm) with statistically non-significant difference at p<0.05, (Table 5, Fig. 9).

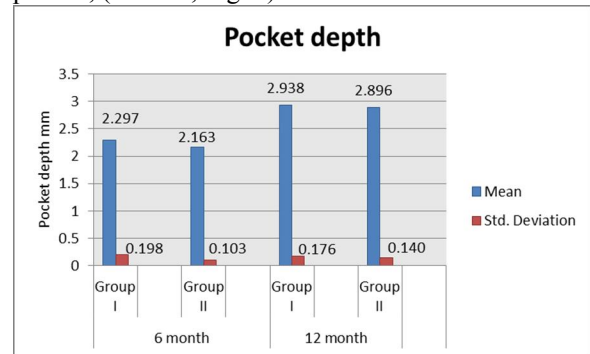


Figure 8: mean and standard deviation of pocket depth in mm for both groups at 6 and 12 months.

Table 5: mean, standard deviation and t-value of gingival index at 6 month of both groups.

	Groups	Mean	Std. Deviation	t(p)
Gingival index 6 month	Group I (N=28)	0.637	0.536	0.255 (0.800)
	Group II (N=14)	0.654	0.482	

t: for independent t-test
*: significant at p<0.05

After twelve months of loading, the mean value of the gingival index of group I (1.018 ± 0.935) was higher than group II (0.732 ± 0.639) with statistically non-significant difference at p<0.05, (Table 6 and Fig. 9).

Table 6: mean, standard deviation and t-value of gingival index at 12 month of both groups.

	Groups	Mean	Std. Deviation	t(p)
Gingival index 12 month	Group I (N=28)	1.018	0.935	1.026 (0.311)
	Group II (N=14)	0.732	0.639	

t: for independent t-test
*: significant at p<0.05

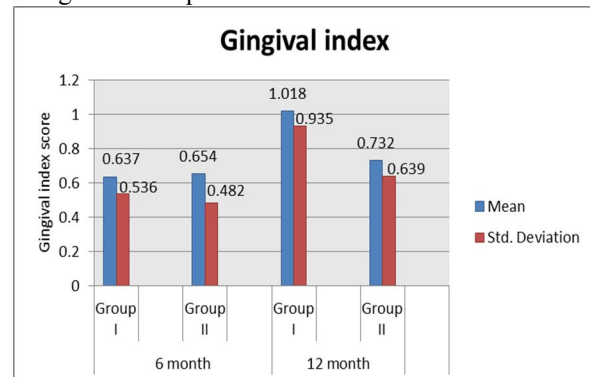


Figure 9: mean and standard deviation of gingival index for both groups at 6 and 12 months.

4. Discussions

Completely edentulous patients are frequently suffering from the inadequate retention and stability of their mandibular dentures. Most of these patients preferred the implant overdenture as an economic, esthetically acceptable and applicable line of treatment. Nowadays, the use of mini-implant overdenture becomes a rapid and technically easier replacement of the conventional implant overdenture (Dang, 2011) and (Šćepanović et al., 2012).

Mini-implant overdenture differs from the conventional overdenture in multiple aspects. The minimal number of implants used for conventional mandibular overdenture is two implants while four mini-implants are mandatory for mini-implant overdenture (Zahrán, 2008), (Sohrabi et al., 2012). Moreover, conventional implant could be placed as immediate, early, or delayed loading protocols (Misch, 2008). On the other hand, the mini-implant overdenture is fabricated upon immediate loading single piece mini-implants (Christensen, 2006), (Ahn et al., 2004), (Šćepanović et al., 2012). Thus, the present study focused on comparing the conventional and the mini-implants as an overall line of treatment regardless the other factors that may affect the collected data. Bone height, pocket depth and gingival index were selected as parameters of implants longevity.

Regarding the present study, the results of the marginal bone height of the group I (mini-implant overdenture) at 6 month showed more average marginal bone loss (0.758 mm) than group II (0.652 mm), with a statistically significant difference at ($p < 0.05$). In addition, the marginal bone height loss after 12 months showed also a more bone loss in group I than group II (1.023 mm and 0.936 mm respectively), at ($p < 0.05$). This finding is consistent with several studies that deal with the use of mini-implants or narrow diameter implants as an implant treatment (Zarone et al., 2006) and (Astrand, 2004). Similarly, Romeo et al., (2006) investigated the clinical outcome of both narrow and standard implant using 330 implants over a 7-year period. They revealed a cumulative survival rates equal 96.9 percent in mandibular arch versus 92.0 percent respectively. Zarone et al., (2006) also observed 0.6 mm bone loss 6 months after loading of narrow neck ITI implants placed in maxillary arch following immediate loading protocol. This is also in agreement with the present study where most of the bone loss occurred during the first 6 months after surgery. Similar observations were made for AstraTech and Brånemark implants, suggesting a steady state in marginal bone levels 5 months after fixture placement (Astrand et al., 2004). On the other hand, a multicenter study was conducted on 1029 one-piece

mini dental implants. They showed high failure rates reached 31 percent in patients treated with four interforaminal implants. This difference is suggested to be attributed to the follow-up time (Bulard and Vance, 2005).

Generally, researches that measures bone level changes confirmed that many variations exist among individuals and differ in the same patient from year to year (Chaytor et al., 1991). Time dependent crestal bone loss was unavoidable around implants, although the rate tends to reduce after 6 months (Hekimoglu, 2004). Moreover, crestal bone loss is an early manifestation of wound healing occurs one month after implant placement and the primary stability of the implant plays an important early role in crestal bone levels (King et al., 2002). Subsequently, after one year crestal bone loss has been attributed to several biomechanical factors (Hekimoglu, 2004). The amount of bone resorption occurring after loading may be related to many factors as the amount of load, nature of the prosthesis, bone quantity and quality and implant related factors. Marginal bone loss around conventional implants supporting mandibular overdentures has been reported to range from 0.2 to 1.9 mm after the first year (Naert et al., 1998) and (Gotfredsen and Holm, 2000). The percentage of bone loss was highest during the first 6 months, after which the rate of bone resorption tended to decrease until becoming stable. This behavior was observed in both groups of the present study and was similar to that observed around conventional implants.

The data of the present study supports the use of four mandibular mini-implants as a recommended standard implant's number for overdenture treatment. This is also consistent with Canizalis's study (2011), which revealed that there is no any preference when an extra mini-implant was added in the incisors area.

In addition, Flanagan (2006) conducted several studies regarding mini-implants and debated that the use of small diameter implants when a standard implant could be used. He clarified that the small the implant size used the lesser the surface area in contact with the bone and so more occlusal force controlling factors are required. Conversely, he added that very small diameter implants might have physiological preference. He clarified that the circumference of a 2 mm implant is 6.28 mm whereas the circumference of a standard 4 mm diameter implant is 12.56 mm. Accordingly, the small implant has half of the linear percutaneous exposure thus exposing less of the implant-gingival attachment to bacterial attack. He also expected an extra available osseous blood supply for the implant supporting bone and so better angiogenesis. In larger

diameter implant a barrier to blood supply may hinder angiogenesis and subsequent osteogenesis around a newly placed implant compared to the smaller implants (Flangen et al., 2010), (Flangen et al., 2008), (Flangen, 2008).

One of the significant factors that could be attributed to the results of the present study is the implants position. The major objective of selecting implant overdentures is to reduce the force transmitted to the implants by sharing the load with the residual ridge. In order to assure the success of this design, a smooth hinge movement of the overdenture should be allowed to reduce force on the implant area to be transmitted to the posterior residual ridge (Misch, 2008). In the present study, the posterior two implants of the mini-implant group showed more bone loss than the anterior two implants in both 6 and 12 months. Although this posterior mini-implant played a protective role for their anterior counterpart, their bone loss compromised the overall outcome of this group. Thus, the previous finding could be attributed to mini-implant position that may suppress overdenture hinge movements. This was agreed with Elsayed et al., (2011) investigations, they conducted a 3-year prospective follow-up to collect and calculate the cumulative survival and success rates of the MDIs were 96.4% and 92.9%, respectively. They recommended positioning of MDIs in canine and first premolar area bilaterally to enhance free overdenture rotation during posterior loading, with twist-free load transmission to the implants. In contrast, equal distribution of MDIs in the interforaminal area increases the chance of implant overloading by rotation of the distal cantilevered portions of mandibular overdenture because of mucosal resiliency.

Another proposed reason for reduced bone loss around MDIs could be claimed to the load transferred to the bone implant interface by a horizontal force that is reported to be greater in narrow than in conventional-diameter implants using finite element stress analysis method (Bulard and Vance, 2005).

In contrast, the proponents of the mini-implants attributed their results to the flapless placement technique of MDIs that causes minimal disruption to the periosteum, preserves peri- and endosteal blood supply and preserves the bone height around the implants after surgery (Himmlova et al., 2004). Furthermore, the auto-advance technique used in MDI's insertion causes bone compression (Himmlova et al., 2004), which may serve to increase bone density in the area immediately surrounding the implant and minimize crestal bone loss. Moreover, the resilient O-ring female housing acts as a shock

absorber and produces less bending moments on the MDIs (Elsayed et al., 2011) and (Baker and Ivanhoe, 2003).

The pocket depth results were consistent with the bone height results. However, the statistically significant difference between the two groups was only recorded after 6 months. This increase in probing depth is considered as a common change relative to other similar studies and is considered within the permissible range of the criteria for implant success (Hermann et al., 2001) and (Tennenbaum et al., 2003). Additionally the single piece mini-implants provide a gap free connection (bacteria proof) and therefore getting the optimal effect of the barrier and protection functions of the peri-implant soft tissue. This also allows the establishment of a tissue collar overlapping the bone implant interface ((Himmlova et al., 2004) and (Balaji et al., 2010). Karoussis et al., (2004) showed that the marginal bone level, pocket depth and probing attachment level of implants were significantly associated with smoking, general health; implant location and full mouth probing depth. As a result, the clinician must consider the patient's general health, smoking habit and oral hygiene for successful treatment. More than 70% of patients had less than 3 mm pocket depth and 90% of them had less than 2 mm tissue recession after loading the implants. These results are comparable to other studies ((Balaji et al., 2010) and (Heydenrijk e al., 2002).

In the present study the two groups showed statistically insignificant increase in gingival index throughout the study period, which may reflect the easiness in oral hygiene maintenance of the ball attachments due to facilitated denture insertion and removal, and the patients compliance to the given oral hygiene instructions.

Although mini-implant overdenture is a successful alternative for conventional two-implant overdenture, the conventional overdenture treatment option exhibited more favorable clinical and radiographic outcome than mini-implant overdenture.

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