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Research Araştırma

Survival Rate of Dental Implants in Horizontal Alveolar Distraction Osteogenesis

Yatay Alveolar Distraksiyon Osteogenezinde Dental İmplantların Sağkalım Oranı

ABSTRACT

Distraction osteogenesis (DO) is the surgical technique of generating new bone by progressive stretching of divided bone segments. Alveolar DO was introduced as an effective new technique for ridge augmentation in vertical and horizontal directions. The aim of this study was to evaluate the clinical outcomes of horizontal alveolar DO, by assessment the survival rate of dental implants placed in the distracted bones.

12 systematically healthy individuals, with reduction in the width of alveolar bone in posterior mandible, bone reconstruction was done by horizontal alveolar DO. After 4 months dental implants were placed. The survival rate of dental implants was assessed in two periods: the first before functional loading (4 months), and the second after functional loading (lasted to 6 months).

Survival rates of dental implants were 100% in the first period and 94.1% in the second.

Distraction osteogenesis can be an effective and reliable surgical method to correct deficits of edentulous ridges.

Key words: Alveolar Bone, Distraction Osteogenesis (DO), Dental Implant, Survival Rate.

ÖZ

DO, ayrılmış kemik segmentlerinin aşamalı gerilmesiyle arada yeni kemiğin olustuğu cerrahi tekniktir. Alveolar DO, vertikal ve horizontal yönlerde aveolar kemik ogmentasyonu için etkili bir teknik olarak tanıtılmıştır. Bu çalışmanın amaçı, horizontal alveolar DO nun teknik sonuçların, ve distrakte kemiklere yerleştirilmiş dental implantların sağ kalım oranını değerlendirmektir.

Mandibular posterior alveolar kemik genişliğinde azalma olan 12 sağlıklı bireyde horizontal alveolar DO ile kemik rekonstrüksiyonu yapıldı. 4 ay sonra, dental implantlar yerleştirildi. Dental implantların sağ kalım oranı iki periotta değerlendirildi. Fonksiyonel yüklemeden önce (4 ay), ve ikincisi: fonksiyonel yüklemeden sonrası (6 ay sürdü).

Dental implantların sağkalım oranları birinci dönemde % 100, ikincisinde % 94.1 bulundu.

DO dişsiz alveolar sırtların eksikliklerinin düzeltilmesinde etkili ve güvenilir bir cerrahi yöntem olabilir.

Anahtar sözcükler: Alveolar Kemik, Distraksiyon Osteogenezi (DO), Dental İmplant, Sağkalım Oranı.

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İNTRODUCTION

Unfavorable local conditions of the alveolar ridge, due to atrophy, periodontal disease and trauma sequelae, may provide insufficient bone volume or unfavorable vertical, transverse, and sagittal interarch relationship, which may render implant placement impossible or incorrect from a functional and esthetic viewpoint (1).

Many different techniques have been developed to reconstruct deficient alveolar jaws for the placement of dental implants performed either in combination or in a second stage surgery after a period of healing (2). Bony regeneration and reconstruction in patients with severely atrophic ridges have been always controversial, and although many techniques have been suggested there is no consensus about the most efficient technique (3). The quantity and quality of regenerated bone must be considered (3,4), As the bone quantity and quality may be a critical parameter for osseointegration.

Alveolar distraction osteogenesis (DO) is a new technique for alveolar ridge augmentation; it can be used to obtain sufficient alveolar bone and mucosa (5). The vertical alveolar DO technique is now applied widely to correct alveolar ridge defects or atrophy (6-10). Horizontal DO for correcting a narrow alveolar ridge has also been reported (11-16).

In general, distraction osteogenesis is defined as the formation of new bone between the vascular surfaces of osteotomized bone segments, separated gradually by distraction forces (17). Histologic results seem to demonstrate that application of DO in alveolar bone allows the formation of an adequate quality and quantity of bone tissue, which can allow primary stability of implants and favorably withstand the biomechanical demands of loaded implants (18-20).

The aim of this study was to evaluate the clinical outcomes of horizontal alveolar DO, by assessment the survival rate of dental implants placed in the distracted bones.

MATERIALS and METHODS

This study included 12 systematically healthy individuals, 2 males and 10 females, aged between 19 and 62 years (mean: 40.3 years), all these patients had reduction in the width of alveolar bone in posterior region of the mandible. DO technique was applied in all cases to increase the width of the alveolar bone in this region before dental implants placement.

Inclusion criteria:

1) Decreasing in the width of the alveolar bone, but not less than 3 mm,
2) absence of any facial bone concavities,
3) bone height at least 10 mm over mandibular canal,
4) absence of any systemic diseases including those affect bone healing,
5) no previous radio or chemotherapy,
6) absence of any disease in soft tissue over the surgical site and
7) the patient should not be smoky or alcoholic with good oral hygiene.

Surgical technique: Under local anesthesia, tow incisions were made in the soft tissue: the first a crestal mucoperiosteal incision is made followed by buccal vertical mucoperiosteal incisions placed anterior to the distraction zone, then the alveolar bone exposed just on the crest of the alveolar bone and on the mesial region (figure 1), in the distal a tunnel was made by the periosteal elevator, then the bone cuts were done in these three regions without mucoperiosteal flap elevation to preserve the blood supply of the buccal cortical bone, then the alveolar bone was splitted by bone osteotomes (figure 2), so the buccal plate is “green-stick” fractured buccally (figure 3) and the distractor fixed (figure 4).

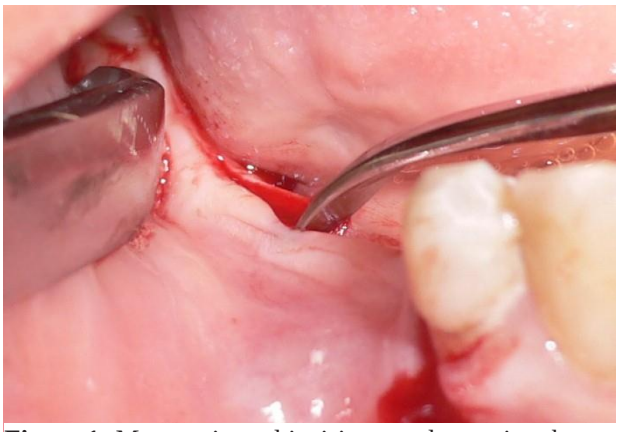

Figure 1: Mucoperiosteal incisions, and exposing the alveolar crest

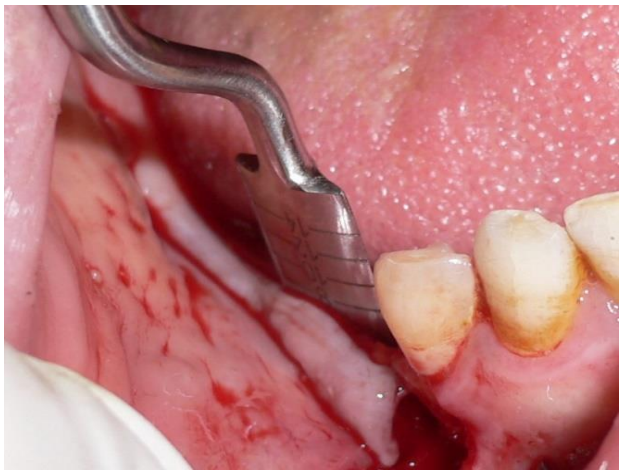

Figure 2: Alveolar bone splitting by osteotomes.

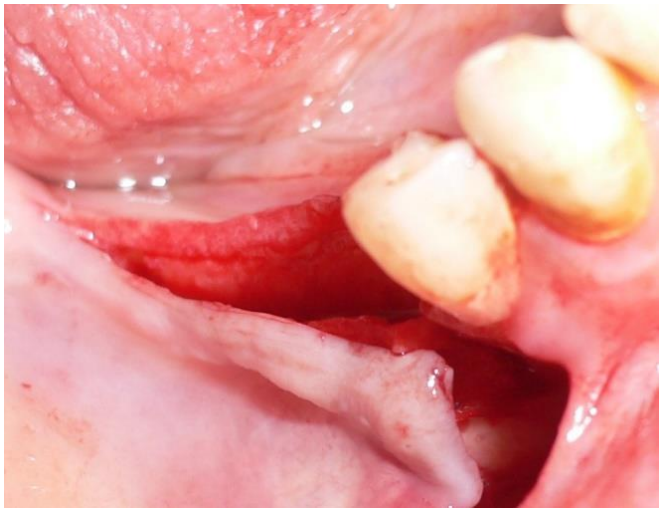

Figure 3: Alveolar bone after splitting.

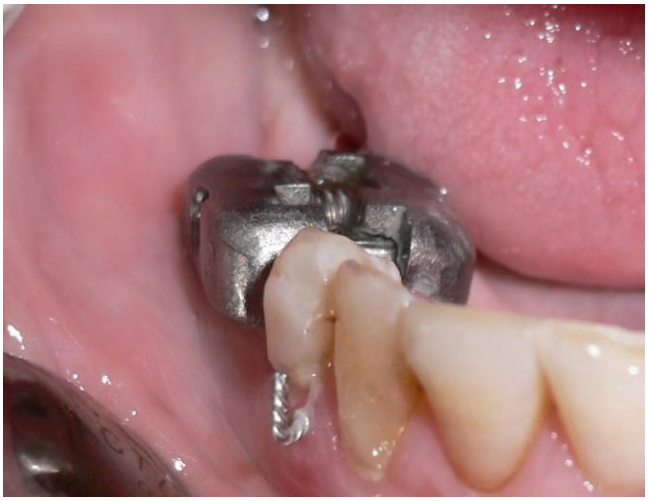

Figure 5: The distractor before removing.

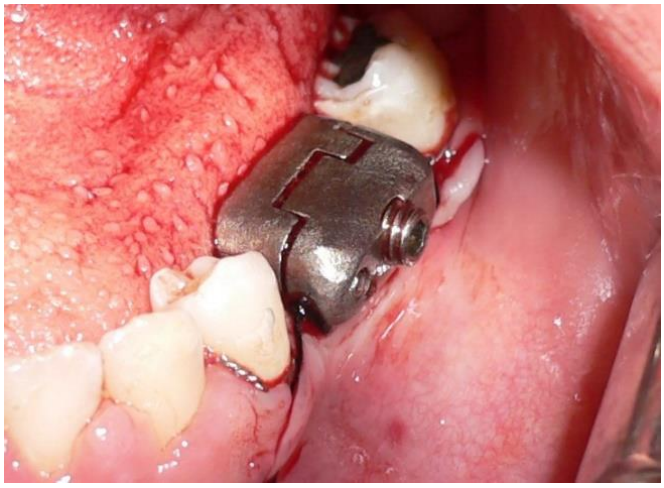

Figure 4: Distractor fixation.

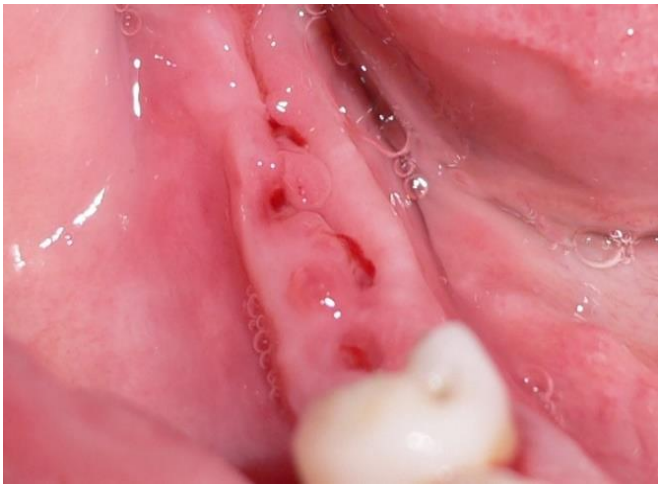

Figure 6: Alveolar ridge after distractor removing.

The distractor was made by the author, and it consists of 4 arms, 2 on each side connected with the body which included an activating distraction screw. The arms are inserted inside the space of the splitting, and by rotating the activating screw, the pair of arms moves apart.

After fixation the distractor was activated to check the movement of the buccal bone plate, then the suture was done, antibiotic and non-steroidal inflammatory drugs were prescribed. Postoperative instructions included a soft diet and appropriate oral hygiene with 0.2 chlorhexidine mouth rinse.

After the latency period (7 days) the sutures were removed and the distraction period started by activating the distractor in rate of 0.75 mm/day divided to three times (every time 025 mm). After 6 days of activation the consolidation period lasted to 6 weeks, then the distractor removed (figure 5, 6).

Dental implants placement

After four months of surgery the 17 dental implants from CSM system were placed in the regions of distraction osteogenesis (figure 7). The diameters of all implants were 3.8 mm, while the lengths were between 8 and 12 mm.

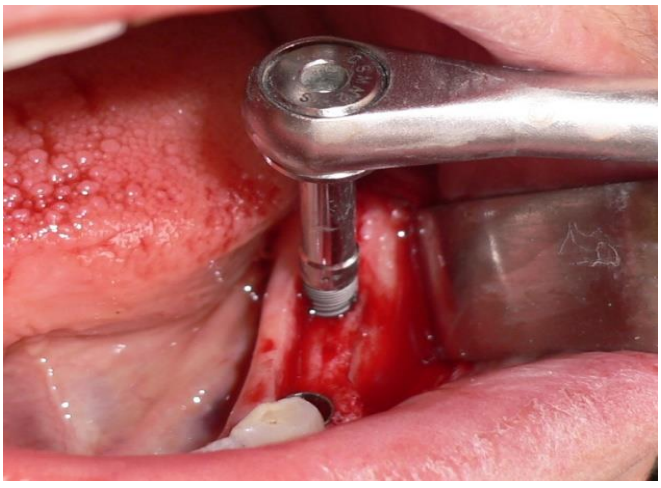

Figure 7: Dental implant insertion.

Under local anesthesia mucoperiosteal flap was elevated, then on the standard drilling technique, the implantation sites were drilled according to the manufacturer's protocol of CSM system (guided drill, initial drill 2.25 mm, drill 3.5 mm, drill 3.8 mm and then implant placement). The drilling speed was 800 rpm with external irrigation by normal saline. After placement the implants were covered by the healing screws then the suturing was done by silk 0.3, and mouth rinse with antibiotic and non-steroid inflammatory were prescribed, finally panoramic x-rays were done immediately after implantation for all patients.

Functional loading of dental implants

After four months of implantation (healing period), the dental implants were exposed by small incisions and the gingival formers were applied for two weeks, then the impressions were done by external technique, in the laboratory the abutments and final restorations (crowns or bridges) were prepared, and finally fixed in the mouths of patients.

Survival rates of dental implants

The survival rates of dental implants were studied in two periods:

1- The first period: in the initial healing periods (before functional loading), between the surgical placement of the implants and the time of gingival former application (4 months).

2- The second period: after functional loading, lasted to 6 months.

Criteria of survival rate

To determine the survival of the implants, the following criteria were considered: 1) absence of mobility (clinical stability), 2) absence of persistent pain or dysesthesia, 3) absence of peri-implant infection with suppuration and 4) absence of continuous radiolucency around the implant. Thus, the implants were classified as failed or surviving.

1- Absence of mobility (clinical stability)

The clinical stability was evaluated in two different methods according to the period of evaluation.

a- The first period (before functional loading): The measurement of implants stability was done by resonance frequency analysis (RFA), by using the Osstell Mentor system. The magnetic transducer (Smart peg) was inserted and the probe of the wireless device was placed in the proximity of the transducer without contacting the peg, until the machine registered the ISQ value. The measurement was done from two directions: buccual-lingual and mesial-distal (figure 8, 9), and the average considered as final value of stability. The dental implant considered stable if the ISQ value ≥ 40.

b- The second period (after functional loading): the evaluation of implant stability depended on two methods: 1) patient's complaint of a movement in the prostheses over the implant, taking into account that the movement can be caused by dissolution of the cement under the prostheses, or from a movement in abutments. 2) Clinical examination, through percussion test, and application of buccal-lingual forces alternately.

2- Absence of persistent pain or dysesthesia: depended on the patient's complaint and clinical examination by percussion.

3- Absence of peri-implant infection with suppuration. Also it depended on the patient's complaint of the inflammation signs and symptoms especially the presence of suppuration, in addition to the clinical examination which done at the end of the two periods.

4- Absence of continuous radiolucency around the implant: bone resorption was examined by panoramic x-rays taken 3 times, immediately after implant placement, at the time of functional loading and after 6 months of functional loading.

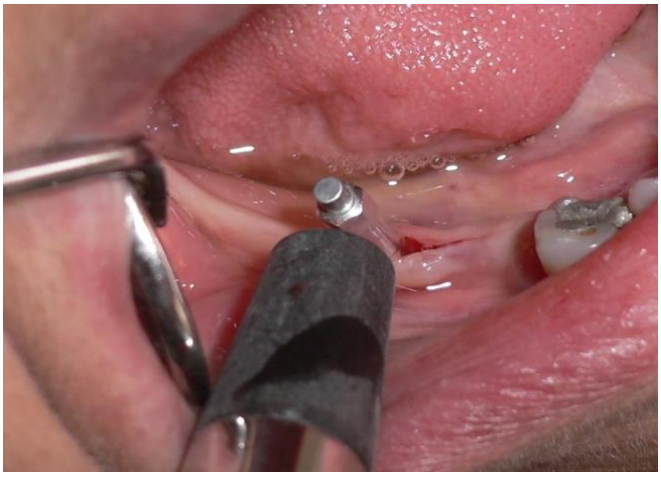

Figure 8: Measurement the implant stability by RFA from the buccual-lingual direction.

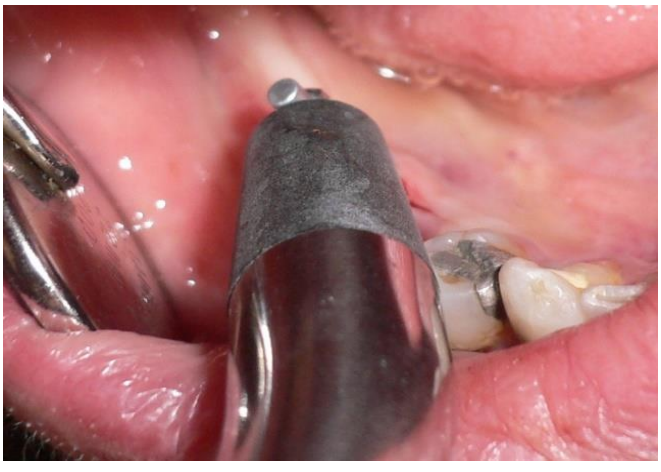

Figure 9: Measurement the implant stability by RFA from the mesial-distal direction.

RESULTS

1- The first period (before functional loading)

The results showed survival rate of 100%, so all the dental implants were stable, because the ISQ value of all implants were above 40 at the end of this period, no persist pain or dysesthesia, nor peri-implant infection with suppuration were recorded and the radiographic assessment did not show radiolucent refer to failure of the osseointergration. But in one implant there was clear bone resorption around it, but the ISQ value was 66 with no pain and no signs and symptoms of infection.

2- The second period (after functional loading)

In this period a failure of one implant was recorded, and it was the same implant of bone resorption, after two months of functional loading the patient complained from a movement in the prostheses over the implant, by clinical and radiographic assessment appeared that the movement was in the implant and the radiolucent became along the implant.

The other implants were stable without pain, signs and symptoms of infection and no abnormal radiographic resorption or radiolucent. So the survival rate in this period was 94.1%.

DISCUSSION

Ilizarov established the concept of distraction osteogenesis for orthopedic surgery in the early 1950s (21,22). Subsequently, the idea was introduced to the field of oral and maxillofacial surgery by McCarthy and coworkers in 1992 (23). In 1996, alveolar DO was introduced as an effective new technique for ridge augmentation (24). Currently, DO is accepted as a promising method for augmentation of atrophic alveolar ridges (24–26) Until now, however, most reports on DO for alveolar processes have dealt with vertical DO, and there have been relatively few reports on horizontal DO for expansion (11,15). Compared with vertical DO, there are some technical difficulties with horizontal DO. A splitting osteotomy is necessary for a thin alveolar ridge which can be extremely difficult (15). So it is similar to alveolar split grafting but without the graft (11).

In this study the DO technique for horizontal expansion of the alveolar bone was applied in the posterior region of mandible in 12 cases after splitting the buccal plate, according to the sequence of this technique and benefiting from the experiences of previous studies in alveolar DO.

Distraction osteogenesis (DO) is a technique of bone generation by progressive bone fragment elongation within the gap region created by osteotomy (27). Ordinarily, after osteotomy and distractor fixation procedures, distraction osteogenesis consists of 3 sequential phases (28):

1) Latency: is the period between bone division and device's activation that allows formation of a primary bone callus. Ilizarov's protocol established a latency period of 5 to 7 days. A latency period of 7 days reduces the risk of bone exposure to the oral environment and is thus probably the optimal choice in the majority of cases of alveolar DO (27).

2) Distraction: is the phase in which the stretching promoted by the activated distractor stimulates tissue neo-formation at the distraction gap.

During this period, the frequency of activation and distraction rate should be judiciously applied (28). Ilizarov suggests that a distraction rate of 1 mm a day in 4 increments of 0.25 mm each offers better results (22). In general too slow a rate could result in premature union, while non-union can occur if the rate is too rapid. In alveolar DO it seems that the rhythm of distraction has tended to be chosen empirically, perhaps reflecting a lack of experimental findings on alveolar distraction (27). Chiapasco et al. in a review found the rate of distraction per day ranged from 0.5 to 1mm in alveolar DO (1). In another review Saulacic et al. found the mean rate of distraction per day was 0.71- 0.27 mm (range 0.25–1 mm) (27).

3) Consolidation: is the period after the end of the distraction when the fragments are stabilized at an ideal position. The length of consolidation period varies from 4 to 12 weeks (29,30) but 8 weeks seems to be sufficient for bone maturation (27,31). In an experimental study of horizontal DO, woven bone was observed in the distraction gap at 12 weeks and new mature lamellar bone was observed at 24 weeks (32,33). The clinical data showed that 3 months of consolidation were enough before implant placement could be performed (14,15,34).

Chiapasco et al. in review found that prosthetic rehabilitation was started 3–6 months after implant placement in alveolar DO (1).

The successful treatment of dental implants is considered to be influenced by both the quality and the quantity of available bone for implant placement. Studies have shown higher failure rates for implants placed in bone of poor quality and quantity (35). Alveolar DO in reconstructed jaws can produce consistent evidence of bone regeneration, with stable

augmentation results clinically, histologically, and radiographically, thus making it a predictable surgical procedure prior to oral implant rehabilitation (36,37). But there are only few data from the literature concerning the long-term survival rate of implants in the mandible after distraction osteogenesis in partially edentulous patients (38).

Several dental health criteria have been adapted for implants. The clinical criterion most commonly reported is the survival rate, or whether the implant is still physically in the mouth or has been removed. A majority of reports that include clinical criteria include mobility, radiographic assessment, and gingival and plaque indices. Subjective criteria of discomfort and patient satisfaction also are mentioned (39). Based on the International Congress of Oral Implantologists (ICOI) Pisa Consensus Conference implants are categorized as "survival" when: No pain or tenderness is observed on palpation, percussion, or function. No observable mobility exists with loads less than 500 g. Radiographic crestal bone loss is between 2.0 and 4.0 mm from the implant insertion (40).

Successful osseointegration is a prerequisite for functional dental implants, and primary implant stability is a prerequisite for successful osseointegration (41).Primary stability is the absence of mobility in the bone bed after implant placement (42). A number of devices and techniques have been developed to assess implant stability (35, 43).

Resonance frequency analysis (RFA) offers a clinical, noninvasive measure of stability and presumed osseointegration of implants (44,45), being a useful tool to establish implant loading time (46). The RFA values are represented by a quantitative unit called the Implant Stability Quotient (ISQ) on a scale from 1 to 100, and are measured with the Osstell® (Integration Diagnostics AB, Gothenburg, Sweden); an increased ISQ value indicates increased stability (44,46). In general the dental implants are considered clinically stable when the ISQ values are between 40 and 80 (47). Huwiler et al found that the ISQ values of successfully placed implants during healing period were between 57 and 70 (48).

Park et al 2010 found that it is possible to obtain two different ISQs, measured from two different directions, for one implant. The identification of the higher and lower ISQ during the two directional measurements may enable the collection of new data on changes in bone–implant stiffness through the use of RFA, which a single directional measurement may ignore (49). For that in this study the measurement of implants stability is done from two directions and the average recorded, and the implants are considered clinically stable when the ISQ ≥ 40.

Also percussion tests have also been used to assess osseointegration implant stability, but this technique is considered generally inadequate in the clinical setting. When implant stability is evaluated with percussion tests using dental implants, the procedure often results in "more information about the tapping instrument and will at best only reveal poor qualitative information" (50). Therefore, percussion tests are limited since the process only provides quick distinction between mobile and osseointegrated implants but does not reveal the degree of implant stability and thereby restricts the ability of rehabilitation specialist to monitor and advance progressive weight-bearing regimens (51,52).

Pain and tenderness are subjective criteria and depend on the patient's interpretation of the degree of discomfort. Percussion and forces up to 500 g are used clinically to evaluate tooth or implant pain or discomfort (39).

The results of this study showed that the survival rate of dental implants after 6 months of functional loading was 94.1%. In non-distracted alveolar bone 90%–95% has been reported as the success rate of implants over the 10 years (53), while in distracted alveolar bone Chiapasco et al. in a review of vertical distraction osteogenesis studies found that of 462 implants placed after vertical distraction osteogenesis , 19 were removed (14 preload, 1 postload, and 4 non-specified), with an overall survival rate of 95.9% (range 88% to 100%; median 95.5%) (54). Also Chiapasco et al. found that implants which placed in distracted bone showed a survival rate of 100% at 4 years (55). Jensen et al. found the implant survival rate in the distracted anterior maxilla to be 90.4% (25). Enislidis et al. found the survival rate in the distracted mandible to be 95.7% after a mean follow-up of 39.4 months (range 4.8-58.3 months) post-implantation (38). Saulacic et. al in a review of alveolar distraction osteogenesis found that the survival rate of 469 implants placed in distracted alveolar bone was 97% (27).

So the results from this study agreed with the results of previous studies distracted and non-distracted alveolar bone and seem to demonstrate that distraction osteogenesis can be an effective and reliable surgical method to correct deficits of edentulous ridges.

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