

# A total fixed reconstruction in patients with severe chronic periodontitis and requiring immediate implant placement and loading: A retrospective clinical study

Şiddetli kronik periodontitisli hastalarda tam sabit rekonstrüksiyon: Retrospektif bir klinik çalışma

Mehmet A. ESKAN<sup>1,2,3</sup> 

<sup>1</sup>Department of Periodontics and Endodontics, University at Buffalo School of Dental Medicine, Buffalo NY, USA

<sup>2</sup>Department of Periodontics, NOVA Southeastern University College of Dental Medicine, Fort Lauderdale FL, USA

<sup>3</sup>Clinic Eska, Istanbul, Turkey

## ABSTRACT

**Objective:** Immediate implant placement has become an acceptable treatment alternative in a patient undergoing total edentulism and seeking fixed total restorations. It is still a controversial topic if previous periodontal status such as generalized chronic severe periodontitis has a negative effect on implant survival rate. The focus of this study is, therefore, to determine whether generalized chronic severe periodontitis compromises implant survival rates in a patient seeking an implant-supported full-arch fixed rehabilitation.

**Methods:** Fifty-five consecutive patients with generalized chronic severe periodontitis received 272 implants. Each jaw, 23 mandibles, and 45 maxillae were treated with a fixed full-arch prosthesis. The majority (95%) of the restorations were supported by 4 implants, of which the posterior 2 implants were tilted. All implants were placed immediately, and a provisional functional acrylic prosthesis was delivered on the same day of surgery. Subjects were followed up to 8.8 years. The cumulative survival rate was determined using Kaplan–Meier analysis.

**Results:** The overall follow-up time for survival rate was up to 8.8 years. Nine implants (8 implants in maxilla and 1 implant in mandible) were lost, resulting in an overall cumulative implant survival rate of 96.3%. The axial or non-axial (tilted) placed implants resulted in a similar survival rate. Good soft tissue health was observed in almost 99% of patients. The final prosthesis survival rate was 100%.

**Conclusion:** The results of this retrospective study indicated that patients undergoing total edentulism due to poor prognosis of the remaining teeth were treated successfully by utilizing the immediate implant placement and loading.

**Keywords:** Dental implants, total edentulism, primary implant stability, chronic periodontitis, immediate loading

## ÖZ

**Amaç:** Çekim sonrası implant yerleştirme, total dişsizliğe giden ve sabit-total restorasyonlar arayan hastalar için kabul edilen bir tedavi yöntemi haline gelmiştir. Genel kronik şiddetli periodontitis (GCSP) gibi önceki periodontal durumun implant başarı oranı üzerinde olumsuz bir etkisinin olup olmadığı hala tartışmalı bir konudur. Bu nedenle bu çalışmanın amacı, implant destekli tam ark sabit rehabilitasyon arayan bir hastada GCSP'nin implant başarı oranlarını (SR'ler) etkileyip etkilemediğini belirlemektir.

**Yöntemler:** 55 ardışık GCSP hastası 272 implant yerleştirildi. Her bir çene, 23 alt çene ve 45 üst çene sabit-tam ark protezi ile tedavi edildi. Restorasyonların çoğunluğu (%95) arkadaki iki implantın eğimli olduğu dört implantla desteklenmiştir. Tüm implantlar hemen çekim sonrası yerleştirildi ve ameliyatın aynı günü geçici fonksiyonel akrilik protez teslim edildi. Tüm hastalar 8.8 yıla kadar takip edildi. Kümülatif hayatta kalma oranı Kaplan-Meier analizi kullanılarak belirlendi.

Geliş Tarihi/Received: 04.12.2021

Kabul Tarihi/Accepted: 18.03.2022

Yayın Tarihi/Publication Date: 31.01.2023

Sorumlu Yazar/Corresponding Author:  
Mehmet A. ESKAN  
E-mail: makifeskan@gmail.com

Cite this article as: ESKAN MA. A total fixed reconstruction in patients with severe chronic periodontitis and requiring immediate implant placement and loading: A retrospective clinical study. *Curr Res Dent Sci.* 2023; 33(1): 14-19.



**Bulgular:** Implant başarı oranı için hastalar 8,8 yıla kadar takip edildi. Dokuz implant (maksillada 8 implant, mandibulada 1 implant) kaybedildi, bu da toplam kümülatif implant başarı oranının %96,3 olduğunu gösterdi. Dik ve eğimli implantlardaki implant başarı oranları arasındaki fark istatistiksel olarak anlamlı değildi. Hastaların %99'unda sağlıklı yumuşak doku gözlemlendi. Daimi protez başarı oranı %100 idi.

**Sonuç:** Bu retrospektif çalışmanın sonuçları, umutsuz dişleri olan ve acil implant yerleştirme ve yükleme gerektiren hastaların All-on-4 konsepti kullanılarak başarılı bir şekilde tedavi edilebileceğini gösterdi.

**Anahtar Kelimeler:** Dental implantlar, total dişsizlik, ilk implant stabilitesi, kronik periodontitis, ani fonksiyon

## INTRODUCTION

The most common oral mucosal inflammatory disease is periodontal disease which is one of the highest incidence diseases in humans and a major pathogenic cause for tooth loss via alveolar bone destruction.<sup>1</sup> Patients with generalized chronic severe periodontitis (GCSP) usually might have severe alveolar bone loss and increased vertical distance between the jaws. They might end up developing dentition loss, which compromises chewing, and pronunciation function.<sup>2</sup>

One of the challenges in implant dentistry today is to provide a cost-effective treatment option for patients. Immediate functional loading for total edentulous jaws has become widely popular among surgeons and patients.<sup>3-5</sup> A fixed restoration in patients with total edentulous, also called, the All-on-4, was introduced to maximize the use of available remaining bone in severely resorbed jaws, allowing immediate implant placing and function.<sup>6</sup> This concept avoids regenerative procedures, which increase the treatment costs, patient morbidity, and surgical complications.<sup>7,8</sup> It utilizes 4 implants in a single jaw to support a provisional fixed prosthesis. The anterior and posterior implants are usually placed axially and tilted distally to minimize the cantilever length, respectively. This positioning allows the application of prostheses with up to 12 teeth, resulting in enhancing masticatory function.<sup>3,4</sup> It is well documented that this concept shows a good survival rate (SR) and a low incidence of complications.<sup>4,5</sup>

Implant placement has been used in treatments that provide functional and esthetic resolution for patients who lost 1 tooth or more. Periodontitis and peri-implantitis have been shown to have some microbial and immunological similarities.<sup>9</sup> Therefore, it is important to find out whether patients showing periodontitis previously possess a higher risk of developing peri-implant diseases. Although a higher incidence of peri-implantitis and a lower implant SR were reported in patients with periodontitis,<sup>10-12</sup> it remains to be addressed since a majority of the patients requiring dental implants have missing teeth due to periodontitis.<sup>13,14</sup>

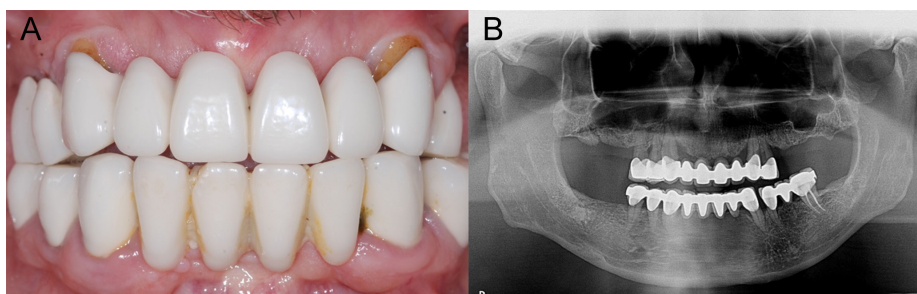
It also has been reported that known periodontal pathogen increases with longer loading time and that this increase is more underlined in patients with a history of periodontitis.<sup>15</sup> It has been shown that the effect of previous periodontitis on implant treatment success in partial edentulism.<sup>16-18</sup> However, a total fixed immediate restoration in a patient with GCSP has been poorly addressed for a long time. This study aims to study if generalized severe chronic periodontitis influences implant SRs in patients seeking an immediate full-arch fixed rehabilitation.

## MATERIAL AND METHODS

This study was conducted in a private clinic in Turkey (Clinic Eska, Istanbul). Fifty-one consecutive patients (30 female and 21 male) were included in this retrospective study. The mean age was 62 and 56 years for female and male, respectively. This study was approved by the University of Uskudar institutional review board. It was also conducted by the Helsinki Declaration of 1964, as revised in 2013. Only patients with hopeless teeth prognosis<sup>19</sup> were included in this study. The prognosis for the saved teeth was good to fair.<sup>19</sup> Periodontal treatments, including surgical and non-surgical, were performed on savable teeth. Patients with a poor/hopeless prognosis and bad oral hygiene went through a gross oral debridement 1 week before the surgery to avoid possible bacterial contamination during the implant surgery. The subject's teeth, undergoing total edentulism (Figure 1), were extracted, and their implants were placed on the day of the surgery. A total of 272 (Nobel Biocare 208 and Straumann 64) implants were placed, supporting 68 fixed full-arch prostheses (axilla 45 and mandible 23) (Table 1). Twenty-five and 26 patients underwent total (upper and lower) and single jaw (upper or lower) edentulism, respectively.

### Inclusion and Exclusion Criteria

The rationale for patient selection was to include all patients who received a fixed full-arch reconstruction during the treatment time, 4-6 months. This time interval was chosen to include the very first patient who received this treatment and all other patients treated in the same manner up to a given date, which



**Figure 1.** Clinical images of a 67-year-old male patient receiving a full-arch maxillary reconstruction. Preoperative intraoral picture (right) and orthopantomography (left) showed a hopeless prognosis in maxillary teeth

**Table 1. Distribution (Upper and/or Lower Jaws) and the Number of Treated Jaws**

Jaws	Number
Mandible	23
Maxilla	45
Single	26
Both	25

allowed for the collection of at least 2 years of follow-up findings for the orthopantomography (OPG) and chewing function evaluation. The subjects who required full-arch rehabilitation and presented teeth with a hopeless prognosis were included in this study. The subjects whose minimum horizontal and vertical bone measured at least 4 and 8 mm, in each patient, respectively, were included. The subjects were excluded when they showed active acute infection at the intended sites of implant placement, uncontrolled diabetes, hematologic disease, radiotherapy, or chemotherapy within the last 12 months.

The radiographic screening was performed using OPG and cone-beam computed tomography. A careful clinical examination of the patients was performed assessing bone volume, jaw size, and their relations.

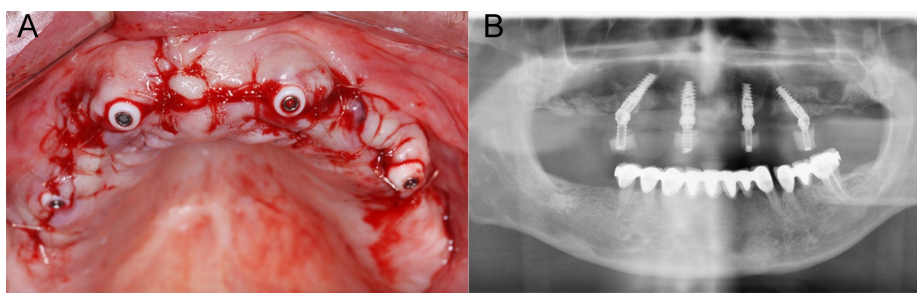
### Surgical Procedures

The surgical procedures were performed under local anesthesia, articaine hydrochloride, and epinephrine (0.012 mg, Safoni-Aventis Deutschland GmbH, Germany). Antibiotics (amoxicillin 1 g) were given twice daily on the day before surgery and then daily for 7 days. Anti-inflammatory medication (ibuprofen, 400 mg) was given for 3 days postoperatively starting on the day of surgery. Before implant surgery, a gross debridement was done to exclude possible calculus contamination at the surgical area. Following the extraction and socket debridement, all sharp edges were smoothed. Implant placement was assisted by a surgical guide (provided by the companies, Nobel Biocare All-on-4 Guide or Straumann® Pro Arch Guide) to estimate the correct implant inclination and accurate positioning of the implants concerning

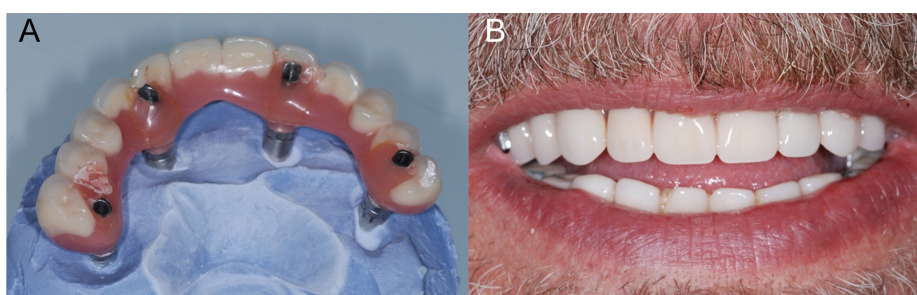
each other. Multi-unit abutments (MUA) were placed. Subcrestal implant placement was used only when needed to create a space for the head of tilted implants. Upon needed, a bone profiler was utilized to create a space for multi-unit implants, especially for the tilted implants. Since the function of the prosthesis is not dependent on the number of implants inserted,<sup>20</sup> an optimal number of implants (4 implants each jaw), consistently with the literature,<sup>21</sup> was placed. The majority of the jaws received 4 implants. When one of the implants in each jaw did not reach the 30 Ncm primary stability, an extra implant was placed. The shortest implant used in this study was 8 mm. However, the posterior, tilted implants were longer than the anterior implants. The tilted posterior implant angulation was corrected with 30-degree (torqued to 20-25 Ncm) MUA. In the anterior area, the implants were introduced with either 0- or 15- to 17-degree MUA (torqued to 20-25 Ncm) (Figure 2). In 3 weeks after the maxillary surgery, his lower jaw treatments including implant placements on the lower right first molar (4.8 x 10 mm, WN SP Straumann) were performed.

### Delivery of Provisional and Final Prostheses

Healing abutments were placed over the MUA. The mucogingival flap was closed primarily using 4.0 resorbable sutures (Pegesorb, Trabzon TR, Turkey). Temporary full-arch acrylic prostheses were delivered on the day of surgery. A small volume of bite registration silicone was placed on a previously made full-arch denture. It was then seated on the healing caps to estimate the placed implant positions. After making holes in the provisional prosthesis, temporary titanium copings were transferred into the temporary prosthesis using a self-curing acrylic. The patient was asked to close in centric relation. The temporary prosthesis was unscrewed from the patient to trim, and polish. No later than 3 hours after surgery, an acrylic provisional with 10 teeth was delivered (Figure 3). Occlusal screws were torqued to 10 Ncm. Regardless of the subjects, a night guard made by hard acrylic plates using a standard vacuum was delivered and asked to each patient to use.

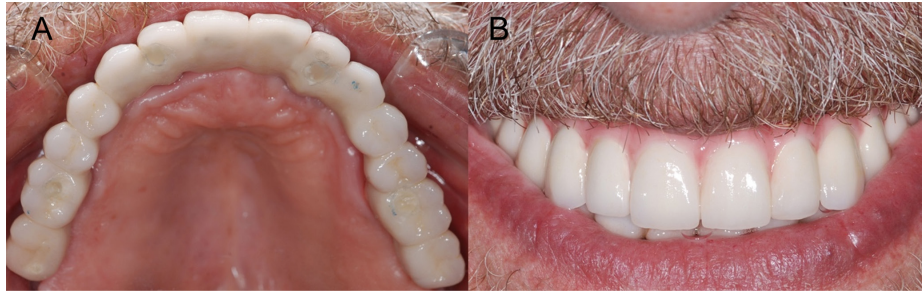


**Figure 2.** Intraoral clinical (left) and radiological (right) view of the placed implant after abutment connection



**Figure 3.** Extra (left) and intraoral (right) view of his temporary prosthesis





**Figure 4.** A view of the final ceramic prosthetic reconstruction, occlusal (left) and buccal (right)

Following the healing time (4 months), an open-tray impression was taken from all the implants, which is considered to be superior to closed-tray techniques.<sup>22</sup> Frameworks for the definitive prostheses were fabricated using CAD-CAM or laser sintering. The final prosthesis, porcelain or acrylic, usually comprised of 12 teeth (Figure 4). The maximum cantilever on each side was no more than 10-12 mm (Figure 5). To ensure no occlusal overloading of implants, especially at the cantilever area, the tilted implants (distal implants) were not tilted more than 30 degrees since more than 30-degree inclination could result in increased occlusal overload.<sup>23</sup> Prosthetically, flat grooves and fossa for wide freedom in centric, shallow occlusal anatomy, a narrow occlusal table, and reduced cuspal inclination were made in both the provisional and final prosthesis since they have been shown to reduce occlusal overloading.<sup>24</sup> An occlusal scheme was obtained with no working, protrusive, or nonworking interference contacts. The canine-protected occlusion was obtained in all cases. Periodic recalls for the subjects were scheduled twice a year to monitor the patients closely.

#### Implant Survival

The primary outcome of this study was to calculate the implant SR (up to 8.8 years). The implant SR was determined using Malo's criteria.<sup>25</sup> An implant was considered successful (100% SR) if it fulfilled the function of supporting the full-arch restoration, was stable when tested clinically, and had no peri-implantitis or suppuration.<sup>25</sup>

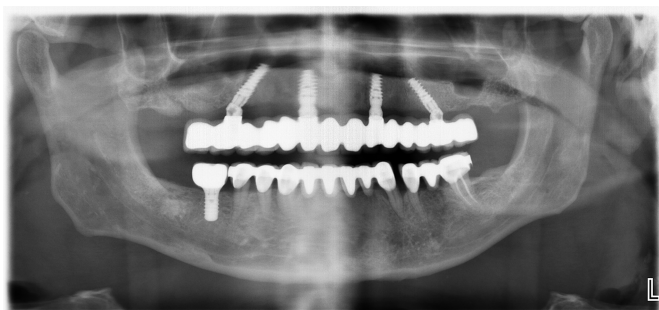
#### Soft Tissue Evaluation

Peri-implantitis, peri-implant mucositis, fistula, bleeding on probing, suppuration, and numbness of the lower lip or chin were assessed.<sup>26-28</sup>

## RESULTS

#### Implant Survival

All patients were followed up to 2-8.8 years after the initial surgery. A total of 272 implants (45 in maxilla and 23 in mandible)



**Figure 5.** The orthopantomography view after the delivery his final prosthesis

were placed (Table 1). Twenty-six patients underwent upper and lower total edentulism. However, 25 patients underwent total edentulism in a single jaw, upper or lower (Table 1). A total of 9 implants failed (8 in maxilla and 1 in mandible), yielding a 96.3% cumulative implant SR for the study (Table 2). Based on the implant brand, 5 and 4 implants were failed from Nobel (97.6%) and Straumann (94.7%), respectively. However, the implant SR between these brands was not significant. All failures were seen before the final prosthesis delivery. Failed implants were removed, and new implants were placed by utilizing different surgical areas or sizes of implants.

#### Mechanical Complications

Mechanical complications included prosthetic screw loosening, final prosthesis fracture, and/or porcelain chipping. Screw loosening and porcelain chipping were seen in 2 and 3 patients, respectively. None of the final acrylic or porcelain restoration was broken. However, around 15% of the temporary prostheses were broken during the implant healing time. These broken prostheses were re-fixed at the chairside and delivered to the patient within a couple of hours. All these patients were identified as bruxers, which was probably the main cause of the screw loosening. After retightening the screws and re-emphasizing the use of night guards, no further loosening occurred during the observation period. Neither implant nor MUA fracture was seen during the observation period.

## DISCUSSION

The current studies have reported that there are similarities between the etiology and pathogenesis of periodontitis and peri-implantitis.<sup>29</sup> This retrospective study indicated the effect of previous severe chronic periodontitis on the implant SR in the patients requiring an implant-supported total fixed immediate function. A cumulative clinical SR (primary outcome of this study) was 96.7% up to 8.8 years, indicating a previous periodontal status could not have much effect on implant SR, indicating the All-on-4 concept can be safely applied on these patients. This study results showed very consistent findings with others.<sup>21</sup>

One of the main factors of losing teeth in the oral cavity is severe chronic periodontitis. It can result in increasing tooth mobility, tooth, and alveolar bone resorption loss, leading to the loss of mastication, self-confidence, and physical and mental health.<sup>2</sup> It is therefore important to provide treatment in those patients

**Table 2.** The Implant Survival Rate in Overall, Maxilla, and Mandible

Important	Survival Rate (%)
Nobel	97.6
Straumann	94.7
Overall	96.3

to regain mastication function. losing teeth due to GCSP. It has been reported that a proper function might play an important role systemically, including controlling blood glucose levels.<sup>30</sup> Immediate function in total edentulous patients can be carried out by the All-on-4 concept. This concept has been shown to reduce the treatment time and patient morbidity without compromising the treatment outcome, implant SR, and success rate for a long time.<sup>5</sup> It is still unclear on the implementation of dental implants in patients with GCSP due to the possible and/or uncontrolled ongoing bone loss.<sup>9</sup> Periodontal pathogens may be transmitted from extracted sockets to implants, leading to bacterial colonization around implants.<sup>11,31</sup> Indeed, studies have shown an increased bone loss at the implants and reduced implant SR in patients with periodontitis.<sup>14,32,33</sup> However, the reports have been indicated that implant placement in patients with periodontitis is not contraindicated, with the majority of studies reporting an implant SR > 90% over 3-16 years, indicating an increased risk of peri-implantitis.<sup>29</sup>

The literature is very limited to addressing the immediate function in a patient with GCSP for a long time. A study showed an implant SR of 83% in 1 year.<sup>34</sup> In contrast to this study, our results showed a good SR of 96.7 in 8.8 years. Systemically given antibiotics pre- and postoperation might be an important factor in controlling a possible infection from periodontal tissues. Studies have shown that systemically administered antibiotics increased the implant SR.<sup>35</sup> In this present study, meticulous debridement of inflammatory tissues after the extraction and given to all patients antibiotic pre-and postoperation could be played an important factor to have a good SR.

The patients in this study showed a high satisfaction with the overall effect of implant-supported fixed total reconstruction following all-teeth extraction. The chewing function and esthetics as well as the quality of life of GCSP patients were dramatically improved by immediate implant and a fixed restoration. Importantly, it avoided for a long time being of total edentulism or the need to wear an uncomfortable total removable denture; these factors perfectly met the demand of patients undergoing complete edentulism. Moreover, more surgical procedures, including sinus and/or a ridge augmentation, were prevented by tilting the implants.

Based on this retrospective study, a fixed full-arch immediate implant placement and rehabilitation could be a viable alternative with high fulfillment in patients with GCSP in 2- to 8.8-year follow-ups. Tilting implants also gave another viable treatment option for the surgeons by avoiding more surgical steps such as bone augmentation. This study had a limited number of patients and was self-controlled. Further clinical studies with longer follow-ups are needed to evaluate implant restoration in GCSP patients with immediate implant placement.

**Ethics Committee Approval:** Ethical committee approval was received from Üsküdar University (Protocol No: B.08.6.YÖK.2.US.O.05.O.06/2018/895).

**Informed Consent:** Written informed consent was obtained from all participants who participated in this study.

**Peer-review:** Externally peer-reviewed.

**Acknowledgments:** I like to thank Sakir Kahraman CDT (dental technicians) for making the prostheses.

**Declaration of Interests:** The author declares that he has no competing interest.

**Funding:** The author declared that this study has received no financial support.

**Etik Komite Onayı:** Bu çalışma için etik komite onayı Üsküdar Üniversitesi'nden (Protokol No: B.08.6. YÖK.2.US.O.05.O.06/2018/895) alınmıştır.

**Hasta Onamı:** Yazılı onam bu çalışmaya katılan tüm katılımcılardan alınmıştır.

**Hakem Değerlendirmesi:** Dış bağımsız.

**Çıkar Çatışması:** Yazar çıkar çatışması bildirmemiştir.

**Finansal Destek:** Yazar bu çalışma için finansal destek almadığını beyan etmiştir.

## REFERENCES

1. Sima C, Viniegra A, Glogauer M. Macrophage immunomodulation in chronic osteolytic diseases-the case of periodontitis. *J Leukoc Biol.* 2019;105(3):473-487. [\[CrossRef\]](#)
2. Slots J. Primer on etiology and treatment of progressive/severe periodontitis: A systemic health perspective. *Periodontol 2000.* 2020;83(1):272-276. [\[CrossRef\]](#)
3. Di P, Lin Y, Li JH, Qiu LX, Chen B, Cui HY. Clinical study of "All-on-4" implant immediate function in edentulous patients. *Zhonghua Kou Qiang Yi Xue Za Zhi.* 2010;45(6):357-362.
4. Eskan MA, Uzel G, Yilmaz S. A fixed reconstruction of fully edentulous patients with immediate function using an apically tapered implant design: A retrospective clinical study. *Int J Implant Dent.* 2020;6(1):77. [\[CrossRef\]](#)
5. Maló P, de Araújo Nobre M, Lopes A, Ferro A, Botto J. The All-on-4 treatment concept for the rehabilitation of the completely edentulous mandible: A longitudinal study with 10 to 18 years of follow-up. *Clin Implant Dent Relat Res.* 2019;21(4):565-577. [\[CrossRef\]](#)
6. Chan MH, Holmes C. Contemporary "All-on-4" concept. *Dent Clin North Am.* 2015;59(2):421-470. [\[CrossRef\]](#)
7. Soto-Penalzoza D, Zaragoza-Alonso R, Penarrocha-Diago M, Penarrocha-Diago M. The all-on-four treatment concept: Systematic review. *J Clin Exp Dent.* 2017;9(3):e474-e488. [\[CrossRef\]](#)
8. Patzelt SB, Bahat O, Reynolds MA, Strub JR. The all-on-four treatment concept: A systematic review. *Clin Implant Dent Relat Res.* 2014;16(6):836-855. [\[CrossRef\]](#)
9. Chrcanovic BR, Albrektsson T, Wennerberg A. Periodontally compromised vs. periodontally healthy patients and dental implants: A systematic review and meta-analysis. *J Dent.* 2014;42(12):1509-1527. [\[CrossRef\]](#)
10. Donos N, Laurell L, Mardas N. Hierarchical decisions on teeth vs. implants in the periodontitis-susceptible patient: The modern dilemma. *Periodontol 2000.* 2012;59(1):89-110. [\[CrossRef\]](#)
11. Koldslund OC, Scheie AA, Aass AM. Prevalence of implant loss and the influence of associated factors. *J Periodontol.* 2009;80(7):1069-1075. [\[CrossRef\]](#)
12. Roos-Jansåker AM, Lindahl C, Renvert H, Renvert S. Nine- to fourteen-year follow-up of implant treatment. Part I: Implant loss and associations to various factors. *J Clin Periodontol.* 2006;33(4):283-289. [\[CrossRef\]](#)
13. Schou S. Implant treatment in periodontitis-susceptible patients: A systematic review. *J Oral Rehabil.* 2008;35(suppl 1):9-22. [\[CrossRef\]](#)
14. Schou S, Holmstrup P, Worthington HV, Esposito M. Outcome of implant therapy in patients with previous tooth loss due to periodontitis. *Clin Oral Implants Res.* 2006;17(suppl 2):104-123. [\[CrossRef\]](#)
15. Lee KH, Maiden MF, Tanner AC, Weber HP. Microbiota of successful osseointegrated dental implants. *J Periodontol.* 1999;70(2):131-138. [\[CrossRef\]](#)

16. Mengel R, Schröder T, Flores-de-Jacoby L. Osseointegrated implants in patients treated for generalized chronic periodontitis and generalized aggressive periodontitis: 3- and 5-year results of a prospective long-term study. *J Periodontol*. 2001;72(8):977-989. [\[CrossRef\]](#)
17. Mengel R, Flores-de-Jacoby L. Implants in regenerated bone in patients treated for generalized aggressive periodontitis: A prospective longitudinal study. *Int J Periodontics Restorative Dent*. 2005; 25(4):331-341.
18. Mengel R, Stelzel M, Hasse C, Flores-de-Jacoby L. Osseointegrated implants in patients treated for generalized severe adult periodontitis. An interim report. *J Periodontol*. 1996;67(8):782-787. [\[CrossRef\]](#)
19. McGuire MK. Prognosis versus actual outcome: A long-term survey of 100 treated periodontal patients under maintenance care. *J Periodontol*. 1991;62(1):51-58. [\[CrossRef\]](#)
20. Klemetti E. Is there a certain number of implants needed to retain an overdenture? *J Oral Rehabil*. 2008;35(suppl 1):80-84. [\[CrossRef\]](#)
21. Maló P, de Araújo Nobre M, Lopes A, Moss SM, Molina GJ. A longitudinal study of the survival of All-on-4 implants in the mandible with up to 10 years of follow-up. *J Am Dent Assoc*. 2011;142(3):310-320. [\[CrossRef\]](#)
22. Siadat H, Alikhasi M, Beyabanaki E, Rahimian S. Comparison of different impression techniques when using the all-on-four implant treatment protocol. *Int J Prosthodont*. 2016;29(3):265-270. [\[CrossRef\]](#)
23. Begg T, Geerts GA, Gryzagoridis J. Stress patterns around distal angled implants in the all-on-four concept configuration. *Int J Oral Maxillofac Implants*. 2009;24(4):663-671.
24. Kim Y, Oh TJ, Misch CE, Wang HL. Occlusal considerations in implant therapy: Clinical guidelines with biomechanical rationale. *Clin Oral Implants Res*. 2005;16(1):26-35. [\[CrossRef\]](#)
25. Maló P, Nobre Mde A, Petersson U, Wigren S. A pilot study of complete edentulous rehabilitation with immediate function using a new implant design: Case series. *Clin Implant Dent Relat Res*. 2006;8(4):223-232. [\[CrossRef\]](#)
26. Klinge B. Peri-implant marginal bone loss: An academic controversy or a clinical challenge? *Eur J Oral Implantol*. 2012;5(suppl):S13-S19.
27. Schuldt Filho G, Dalago HR, Oliveira de Souza JG, Stanley K, Jovanovic S, Bianchini MA. Prevalence of peri-implantitis in patients with implant-supported fixed prostheses. *Quintessence Int*. 2014;45(10):861-868. [\[CrossRef\]](#)
28. Schwarz F, Derks J, Monje A, Wang HL. Peri-implantitis. *J Periodontol*. 2018;89(suppl 1):S267-S290. [\[CrossRef\]](#)
29. Heitz-Mayfield LJ, Huynh-Ba G. History of treated periodontitis and smoking as risks for implant therapy. *Int J Oral Maxillofac Implants*. 2009;24(suppl):39-68.
30. Sato A, Ohtsuka Y, Yamanaka Y. Morning mastication enhances postprandial glucose metabolism in healthy young subjects. *Tohoku J Exp Med*. 2019;249(3):193-201. [\[CrossRef\]](#)
31. Smith MM, Knight ET, Al-Harhi L, Leichter JW. Chronic periodontitis and implant dentistry. *Periodontol 2000*. 2017;74(1):63-73. [\[CrossRef\]](#)
32. Karoussis IK, Kotsovilis S, Fourmouis I. A comprehensive and critical review of dental implant prognosis in periodontally compromised partially edentulous patients. *Clin Oral Implants Res*. 2007;18(6):669-679. [\[CrossRef\]](#)
33. Van der Weijden GA, van Bommel KM, Renvert S. Implant therapy in partially edentulous, periodontally compromised patients: A review. *J Clin Periodontol*. 2005;32(5):506-511. [\[CrossRef\]](#)
34. Cheng Z, Zheng W. Clinical effect and aesthetic observation of all-on-4 immediate loading implant denture in severe periodontitis. *Evid Based Complement Alternat Med*. 2021;2021:3120260. [\[CrossRef\]](#)
35. Mazzocchi A, Passi L, Moretti R. Retrospective analysis of 736 implants inserted without antibiotic therapy. *J Oral Maxillofac Surg*. 2007;65(11):2321-2323. [\[CrossRef\]](#)