



## Change in Bite Force of Completely Edentulous Patients After Placement of Single Implant-Retained Mandibular Overdentures

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### ABSTRACT

**Purpose:** This study aimed to assess the change in the maximum bite force of completely edentulous patients rehabilitated with thermoplastic acrylic complete denture after placement of single implant-retained mandibular overdentures. **Materials and Methods:** Sixteen completely edentulous patients with age ranged from 50-60 years were selected from removable prosthodontic clinics, faculty of dental medicine, Al-Azhar University. Each patient received a thermoplastic acrylic complete denture. Three months after a new denture placement, bite force was evaluated using an occlusal force meter (GM10, Nagano Keiki, Japan). Each patient received a mid-symphyseal single dental implant, 10 mm length and 3.7mm diameter (Dentis, Dalseo-gu, Daegu, Korea) placed at the midline of the mandibular alveolar ridge. Two weeks after overdenture placement, bite force was evaluated to assess the changes in bite force after a single implant placement. **Results:** Bite force was increased considerably after single implant placement. It was significantly higher than the bite force recorded with a conventional thermoplastic complete denture. **Conclusion:** It was concluded that using immediate loading single implant-retained mandibular overdentures resulted in considerable improvement of bite force in completely edentulous patients.

### INTRODUCTION

Numerous individuals have been suffered from loss of teeth, which results in functional disorders, so prosthetic rehabilitation with a proper prosthesis is indicated<sup>(1)</sup>.

Completely edentulous patients with complete dentures are experiencing various issues with their dentures, mostly regarding the mandibular denture, for example diminished stability and retention

### KEYWORDS

Bite force, thermoplastic acrylic dentures, single implant.

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during mastication<sup>(2)</sup>. Denture wearers are also suffering from decreased masticatory performance as the muscles undergo various functional changes with aging, mainly muscle atrophy<sup>(3)</sup>.

Assessment of maximum bite force and muscle changes associated with age is essential, considering the increase in elderly individuals everywhere throughout the world<sup>(4)</sup>.

Maximum bite force [MBF] is a significant variable to evaluate oral function<sup>(5)</sup>. It additionally impacts diet selection, which has a vital role in the maintenance of masticatory activity<sup>(6-7)</sup>. Old age people with missing teeth avoid a fibrous diet, which is considered an essential source of fibers, proteins, and vitamins<sup>(8-9)</sup>.

Many authors reported that the teeth loss and selecting less nutritious regimen by patients resulting in an increased risk of malnutrition and consequently, the likelihood for systemic diseases<sup>(10-14)</sup>.

The bite force of completely edentulous individuals is 20% to 40% of that of healthy dentulous persons. So, edentulous people need till seven times more chewing cycles to reduce food particles than do dentulous persons<sup>(15)</sup>.

The maximum masticatory forces in complete denture wearers may be limited by the pain and discomfort that happens when the denture lose its retention, or even by the fear of such pain<sup>(6,16)</sup>.

Three main factors; retention, stability, and support should be considered for successful complete dentures. Treatment alternatives that help in increasing retention and stability for improving denture function should be considered when the conventional complete denture is inadequate<sup>(17-19)</sup>.

There are many options for the restoration of completely edentulous mouth, like implant-retained overdenture and conventional complete dentures. Complete dentures became very popular since the introduction of acrylic polymers in dentistry due

to factors as the relatively high cost of a dental implant<sup>(20,21)</sup>. One of the recent options is using thermoplastic denture base material<sup>(22,23)</sup>.

Thermoplastic dentures are introduced as an alternative to conventional hard-fitted dentures<sup>(24)</sup>. Thermoplastic resins can be classified as thermoplastic acrylic, polycarbonates, acetal, and nylon<sup>(25,26)</sup>. Flexible thermoplastic denture base materials showed a lesser candidal adherence upon maxillary denture fitting surface than that of conventional heat-cured acrylic resin<sup>(27)</sup>.

Restoration of completely edentulous patients by implant-retained denture is a successful line of treatment, as confirmed by many clinical studies<sup>(28,29)</sup>. Using a single implant placed in the midline symphyseal region to retain an overdenture has been suggested with an excellent success rate according to the success criteria of Albrektsson<sup>(30)</sup>. In addition, this line of treatment can be used as an economical therapeutic option to the conventional complete denture<sup>(31)</sup>.

A finite element study was carried out by Jingyin Liu et al.<sup>(32)</sup> on the implant number required to retain mandibular implant-retained overdenture, found that single implants were able to bear and dissipate the load to the bone well<sup>(32)</sup>.

Even though alveolar ridge height and denture retention which could influence the results, were not investigated, the current study is one of few studies evaluating changes in maximum biting force in completely edentulous patients rehabilitated with a thermoplastic acrylic denture base after insertion of implant-retained complete mandibular overdenture opposing conventional maxillary complete denture.

## MATERIALS AND METHODS

This randomized prospective clinical study, involved sixteen completely edentulous patients randomly selected from Removable Prosthodontic Outpatient clinic, Faculty of Dental Medicine, Al-Azhar University. Based on SD from previous

study of Sharma et al,<sup>(6)</sup> it was found that 16 cases are enough for conducting the research at power 0.80, confidence interval 0.95, and  $\alpha$  level 0.05.

Patients' age ranged from 50-60 years (mean 55Y). After clarification of the study methodology; Informed consent was obtained from all selected patients before enrolment in the study.

The patients were free from any local or systemic diseases that may contraindicate dental implant placement.

### A thermoplastic acrylic complete denture construction

All patients received a thermoplastic PMMA complete denture (Polyan IC™ bredent GmbH & Co.KG, Germany) (Fig. 1). with bilateral balanced occlusion. (group I)



Figure (1): A thermoplastic acrylic complete denture.

### Bite force recordings

The maximum bite force was recorded for each patient with a thermoplastic acrylic complete denture after three months of new denture insertion with the following method. The maximum bite force was recorded bilaterally at the first molar region by an occlusal force meter. The measuring range was 0 to 1000 N. (GM10, Nagano Keiki, Tokyo, Japan). (Fig.2)

The instrument was placed in the first molar region with the patient in an upright position. The patient was instructed to bite at maximum intercuspation as powerfully as he can three times, with a rest period of two minutes in between. The mean maximum occlusal force for the three readings was recorded in Newtons (N).



Figure (2): Occlusal force meter.

### Mid-symphyseal single Implant Placement

For each patient, cone-beam C.T (Kodak 9500 cone-beam 3d System machine, arestream Dental / Kodak. USA) of the mandible were carried out. Each patient received a mid-symphyseal single dental implant, 10mm length, and 3.7mm (Dentis, Dalseo-gu, Daegu, Korea) at the midline of the mandibular alveolar ridge. (Fig. 3).

After two days of implant insertion, the mandibular denture was prepared to be inserted. Locator attachment (Dentis, Dalseo-gu, Daegu, Korea) was screwed into the fixture and tightened using a screwdriver.

The resilient cap was placed over the male part of the attachment and transferred to the base of the denture using a marker past that was placed on the cap, and the lower denture was inserted in the patient mouth, so the corresponding area of the cap would be marked on the fitting surface of the denture. Using a round bur at low speed, housing was created in the fitting surface of the denture in the marked area to create a house for the resilient cap (female part). The appropriate retentive nylon inserts were chosen according to the retention

required. Pink nylon inserts (light retention) were used in this study.

The denture was checked in the patient mouth to be sure that there was no interference with the implants. Auto- polymerizing acrylic resin was placed in the space created in the denture base, and a small amount of resin was injected intraorally on the dry metallic cap.

The denture was inserted into the patient mouth, and the patient was instructed to close, the metal cap would be picked into the base of the denture. When the acrylic resin had set, the denture was removed from the mouth, inspected, and the excess material was removed with a suitable bur. The patients after wearing the implant retained overdenture were designated as group II.

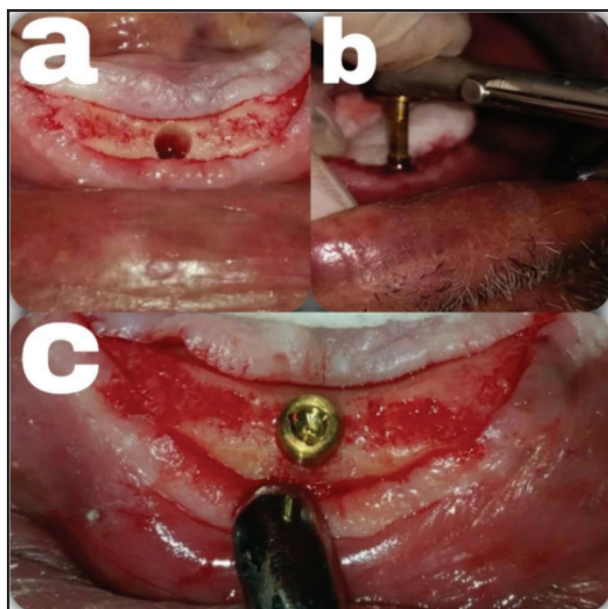


Figure (3): a) Incision, raising flap, drilling. b) Fixture screwing. c) Attachment in place.

Recording maximum bite force was done two weeks after a single implant mandibular overdenture insertion. The difference in bite force for different groups was calculated, and the changes in mean bite force measurements were compared using paired t-test. Statistical analysis was done with SPSS software V.20.

**RESULTS**

The maximum bite force in completely edentulous patients with thermoplastic denture base material was recorded. The mean measurements of maximum bite force for patients receiving thermoplastic acrylic denture were 38.37±10.59 at three months after denture placement. The mean measurements of maximum bite force for patients were 47.50± 9.03 after implant-retained mandibular overdenture placement. (Table 1, Fig 4)

The paired t-test showed that there was a statistical difference in maximum bite force values [ P0.05<]. The bite force is increasing considerably with mandibular overdenture retained with mid-symphyseal single Implant placement. (Table 1).

**Table (1): Bite force measurements for both groups.**

	Grouping	N	Mean	Std. Deviation	Std. Error Mean	Sig. (2-tailed)
MBF	G1	16	38.37	10.95	2.34	.002*
	G2	16	47.50	9.03	1.74	

G1: Conventional thermoplastic complete denture.  
 G2: Mid-symphyseal single Implant-retained mandibular overdenture.  
 \* P-value significant at P ≤ 0.05.

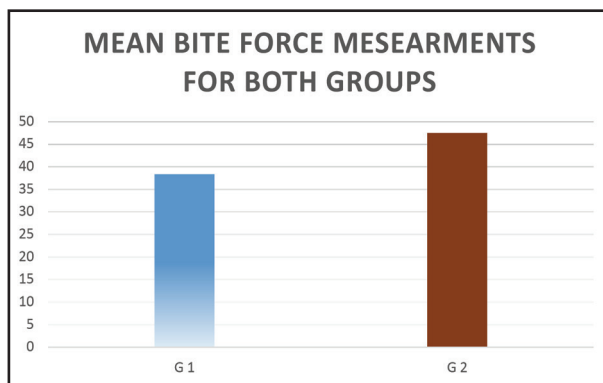


Figure (4): Mean bite force measurements.

## DISCUSSION

The maximum bite force is an important factor for masticatory function evaluation<sup>(33)</sup>. The maximum bite force has different values in various locations in the mouth, and it is highest recorded in the first molar region because most of the biting force is directed in that area<sup>(34,35)</sup>. The bite force is recorded three times for each patient as it is more reliable to measure multiple recordings of maximum bite force than a single record<sup>(36)</sup>.

Patients over 60 years are more vulnerable to the trauma of oral mucosa, stomatitis due to atrophy with a slow turnover of tissues. Old age patients also show a decrease in muscle activity and have weak neuromuscular control. Consequently, patients older than 60 years were excluded from the study<sup>(37)</sup>.

The question raised in this study, is the maximum bite force recorded in completely edentulous patients rehabilitated with a complete thermoplastic acrylic denture is improved significantly after placement of single implant-retained mandibular overdenture.

After conventional complete denture insertion, recording bite force was done after three months as adaptation period for new denture as recommended by Eberhard et al,<sup>(38)</sup> who recommend an adaptation period of 3 months for the complete denture wearer. Recording bite force was done after two weeks after overdenture placement as there is no new denture. The patient already used this denture before and there is no need for additional adaptation period.

Many authors reported that the maximum bite force was considerably higher in patients with a thermoplastic denture base than patients with conventional acrylic denture base with a statistically significant difference after six months of denture placement<sup>(39,40)</sup>.

In this study, all patients recorded better bite force measurements with a mid-symphyseal single Implant-retained mandibular overdenture than maximum bite force values recorded with a thermoplastic denture. This result was in accordance

with the result of Hassan et al.<sup>(41)</sup>, who found that the maximum biting forces improved in conventional denture wearer after insertion of dental implants irrespective of the dental implant system which was used.

The results of this study confirm the value of implant insertion in increasing the bite force of a complete denture wearer. Similar results were found by Geckili et al.<sup>(42)</sup>, who compared bite force between edentulous individuals wearing two implant-supported mandibular overdentures and complete dentures. After four years, they found that patients wearing mandibular two implants supported overdentures had higher values for maximum bite force when compared to individuals with a conventional denture.

Many other studies also support the results of this study, as the studies conducted by Fontijn-Tekamp et al.<sup>(43,44)</sup> who found that the individuals with mandibular implant-retained overdentures had significantly better maximum bite forces than individuals with a conventional complete denture. On the other hand, maximum bite forces did not vary between patients with the mucosa-implant-borne implant and others with mainly implant-borne. So, they concluded that the differences in support for the mandibular implant-retained overdenture are not mirrored in maximum bite force measurements.

The study of Rismanchian et al.<sup>(45)</sup> was in accordance with the result of this study. They evaluated the maximum bite force in conventional denture wearers and individuals wearing maxillary complete dentures opposing two implants retained mandibular overdentures. They found that the mean maximum bite force values were twice as much as with the conventional prostheses.

The higher values observed in patients with mid-symphyseal single implant-retained mandibular overdenture may be directly related to better support and retention obtained with single implant-retained mandibular overdenture.

On the other hand, the results of studies conducted by Mancuso et al.<sup>(46)</sup> and Luraschi et al.<sup>(47)</sup>, concluded that the bite forces in completely edentulous patients with implant-retained overdentures were found to be higher than patients with conventional complete dentures, but the difference was not significant.

Further studies are required to know the prosthodontic outcomes of using different attachment systems and their effect on maximum bite force.

## CONCLUSION

Within the limitations of the current study, there was a statistically significant difference in maximum bite force of patients with the thermoplastic acrylic complete denture in comparison to others with a single implant-retained mandibular overdentures which recorded better maximum bite force values. So using a single implant as an economical therapeutic option is recommended to improve patient bite force.

## RECOMMENDATIONS

Further studies are needed to analyze the relationship between different variables and bite force e.g. a more extended adaptation period, to assess whether the adaptation time can influence the results. Also, electromyographic data during function, an important masticatory variable, may be evaluated to understand the relationship between bite force and masticatory performance.

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## CONFLICT OF INTEREST

The author has no conflicts of interest relevant to this article. The author declares that he has no interest, financial or otherwise, related to any of the products or methods used in this study.

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## REFERENCES

1. Lima de Paula LML, Sampaio AA, Costa JG, Gomes VE, Ferreira EFE, Ferreira RC. The course from tooth loss to successful rehabilitation with denture: Feelings influenced by socioeconomic status. *SAGE Open Med.* 2019;7:1-8.
2. Roffie J, Abd Hamid ZA, Lim TW, Shoji Y, Abd Ghani H. OSC8: Comparison of Maximum Occlusal Bite Force in New Complete Denture with Denture Adhesives: A Preliminary Study. *J Indian Prosthodont Soc.* 2018;18:S10.
3. Campos CH, Ribeiro GR, Stella F, Rodrigues Garcia RC. Mandibular movements and bite force in Alzheimer's disease before and after new denture insertion. *J Oral Rehabil.* 2017;44:178-86.
4. Hakeem FF, Bernabe E, Sabbah W. Association between oral health and frailty: A systematic review of longitudinal studies. *Gerodontology.* 2019;36:205-15.
5. Atassi M, Ling MR, Oneglia K, Dilauro TS. A proof-of-principle bite force study using two experimental test denture adhesives and a currently marketed denture adhesive. *Clin Exp Dent Res.* 2020;6:266-73.
6. Sharma AJ, Nagrath R, Lahori M. A comparative evaluation of chewing efficiency, masticatory bite force, and patient satisfaction between conventional denture and implant-supported mandibular overdenture: An in vivo study. *J Indian Prosthodont Soc.* 2017;17:361-72.
7. Varghese R, Burnett GR, Soverain A, Patil A, Gossweiler AG. A randomised bite force study assessing two currently marketed denture adhesive products compared with no-adhesive control. *Clin Exp Dent Res.* 2019;5:276-83.
8. Almoznino G, Gal N, Levin L, Mijiritsky E, Weinberg G, Lev R, et al. Diet Practices, Body Mass Index, and Oral Health-Related Quality of Life in Adults with Periodontitis- A Case-Control Study. *Int J Environ Res Public Health.* 2020;17:1-15.
9. Shay B, Ben Ami O, Levy Ianculovici D, Zini A, Ianculovici C, Almoznino G. Oral health-related quality of life in patients with disorders of nutrition. *J Oral Rehabil.* 2019;46:355-68.

10. Da D, Wang F, Zhang H, Zeng X, Jiang Y, Zhao Q, et al. Association between tooth loss and hypertension among older Chinese adults: a community-based study. *BMC Oral Health*. 2019;19:1-7.
11. Foratori-Junior GA, Mascoli LS, Jesuino BG, Missio ALT, Sales-Peres SHC. Evaluation of systemic conditions, tooth loss, body image, and quality of life of women with obesity and women who underwent gastric bypass surgery. *Spec Care Dentist*. 2020;40:151-9.
12. Hosadurga R, Kyaw Soe HH, Peck Lim AT, Adl A, Mathew M. Association between tooth loss and hypertension: A cross-sectional study. *J Family Med Prim Care*. 2020;9:925-32.
13. Kim YT, Choi JK, Kim DH, Jeong SN, Lee JH. Association between health status and tooth loss in Korean adults: longitudinal results from the National Health Insurance Service-Health Examinee Cohort, 2002-2015. *J Periodontal Implant Sci*. 2019;49:158-70.
14. Zhao D, Zhen Z, Pelekos G, Yiu KH, Jin L. Periodontal disease increases the risk for onset of systemic comorbidities in dental hospital attendees: An 18-year retrospective cohort study. *J Periodontol*. 2019;90:225-33.
15. Jose A, Varghese R, Roohpour N, Mason S, Jain R, Gossweiler A. A Randomized Proof-of-Principle Bite Force Study of Two Experimental Denture Adhesives and a Commercially Available Adhesive. *Int J Prosthodont*. 2018;31:351-8.
16. Julinda M, Soemarsongko T, Adenan A. OSC4: Retentive Ability and Incisal Bite Force between Aloe Vera and Polymethyl Vinyl Ether (Maleic Acid) as Adhesive Agent in Acrylic Complete Denture. *J Indian Prosthodont Soc*. 2018;18:S8.
17. Roessler DM. Complete denture success for patients and dentists. *Int Dent J*. 2003;53:340-5.
18. Limpuangthip N, Somkotra T, Arksornnukit M. Modified retention and stability criteria for complete denture wearers: A risk assessment tool for impaired masticatory ability and oral health-related quality of life. *J Prosthet Dent*. 2018;120:43-9.
19. Limpuangthip N, Somkotra T, Arksornnukit M. Impacts of Denture Retention and Stability on Oral Health-Related Quality of Life, General Health, and Happiness in Elderly Thais. *Curr Gerontol Geriatr Res*. 2019;2019:1-8.
20. Padmanabhan H, Kumar SM, Kumar VA. Single Implant Retained Overdenture Treatment Protocol: A Systematic Review and Meta-Analysis. *J Prosthodont*. 2020;29:287-97.
21. Sharka R, Abed H, Hector M. Oral health-related quality of life and satisfaction of edentulous patients using conventional complete dentures and implant-retained overdentures: An umbrella systematic review. *Gerodontology*. 2019;36:195-204.
22. Vojdani M, Giti R. Polyamide as a Denture Base Material: A Literature Review. *J Dent (Shiraz)*. 2015;16:1-9.
23. Varshney N, Aggarwal S, Kumar S, Singh SP. Retention and patient satisfaction with bar-clip, ball and socket and kerator attachments in mandibular implant overdenture treatment: An in vivo study. *J Indian Prosthodont Soc*. 2019;19:49-57.
24. Fueki K, Yoshida-Kohno E, Inamochi Y, Wakabayashi N. Patient satisfaction and preference with thermoplastic resin removable partial dentures: a randomised cross-over trial. *J Prosthodont Res*. 2020;64:20-5.
25. Kalivradzhian ES, Soroka DV, Podoprigora AV. The evaluation of the applicability of thermoplastic polymers as a denture base material. *Stomatologija (Mosk)*. 2019;98:92-8.
26. Shah VR, Shah DN, Chauhan CJ, Doshi PJ, Kumar A. Evaluation of flexural strength and color stability of different denture base materials including flexible material after using different denture cleansers. *J Indian Prosthodont Soc*. 2015;15:367-73.
27. Ahmed E, Esmat A, Hassan H. Candida albicans colonization on different polymeric denture base materials in controlled type II diabetic patients. *Journal of The Arab Society for Medical Research*. 2019;14:95-101.
28. Alqutaibi AY. Limited Evidence Suggests a Single Implant Overdenture as an Alternative to Two-implant-Supported Mandibular Overdentures. *J Evid Based Dent Pract*. 2016;16:44-6.
29. Mahoorkar S, Bhat S, Kant R. Single implant supported mandibular overdenture: A literature review. *J Indian Prosthodont Soc*. 2016;16:75-82.
30. Albrektsson T, Branemark PI, Hansson HA, Lindstrom J. Osseointegrated titanium implants. Requirements for ensuring a long-lasting, direct bone-to-implant anchorage in man. *Acta Orthop Scand*. 1981;52:155-70.
31. Amaral CF, Gomes RS, Rodrigues Garcia RCM, Del Bel Cury AA. Stress distribution of single-implant-retained overdenture reinforced with a framework: A finite element analysis study. *J Prosthet Dent*. 2018;119:791-6.
32. Liu J, Pan S, Dong J, Mo Z, Fan Y, Feng H. Influence of implant number on the biomechanical behaviour of

- mandibular implant-retained/supported overdentures: a three-dimensional finite element analysis. *J Dent.* 2013;41:241-9.
33. Yen CI, Mao SH, Chen CH, Chen CT, Lee MY. The correlation between surface electromyography and bite force of mastication muscles in Asian young adults. *Ann Plast Surg.* 2015;74:S168-72.
  34. Shinogaya T, Sodeyama A, Matsumoto M. Bite force and occlusal load distribution in normal complete dentitions of young adults. *Eur J Prosthodont Restor Dent.* 1999;7:65-70.
  35. Tortopidis D, Lyons MF, Baxendale RH, Gilmour WH. The variability of bite force measurement between sessions, in different positions within the dental arch. *J Oral Rehabil.* 1998;25:681-6.
  36. Ikebe K, Matsuda KI, Morii K, Hazeyama T, Kagawa R, Ogawa T, et al. Relationship between bite force and salivary flow in older adults. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod.* 2007;104:510-5.
  37. Lloyd PM. Complete-denture therapy for the geriatric patient. *Dent Clin North Am.* 1996;40:239-54.
  38. Eberhard L, Oh K, Eiffler C, Rammelsberg P, Kappel S, Schindler HJ, et al. Adaptation to new complete dentures- is the neuromuscular system outcome-oriented or effort-oriented? *Clin Oral Investig.* 2018;22:2309-17.
  39. Sakr H, Fayad M. Bite force and oral health impact profile in completely edentulous patients rehabilitated with two different types of denture bases. *Tanta Dental Journal.* 2017;14:173-80.
  40. Fayad MI, Alruwaili HHT, Khan MS, Baig MN. Bite Force Evaluation in Complete Denture Wearer with Different Denture Base Materials: A Randomized Controlled Clinical Trial. *J Int Soc Prev Community Dent.* 2018;8:416-9.
  41. Hasan I, Madarlis C, Keilig L, Dirk C, Weber A, Bourauel C, et al. Changes in biting forces with implant-supported overdenture in the lower jaw: A comparison between conventional and mini implants in a pilot study. *Ann Anat.* 2016;208:116-22.
  42. Geckili O, Bilhan H, Mumcu E, Dayan C, Yabul A, Tuncer N. Comparison of patient satisfaction, quality of life, and bite force between elderly edentulous patients wearing mandibular two implant-supported overdentures and conventional complete dentures after 4 years. *Spec Care Dentist.* 2012;32:136-41.
  43. Fontijn-Tekamp FA, Slagter AP, van't Hof MA, Geertman ME, Kalk W. Bite forces with mandibular implant-retained overdentures. *J Dent Res.* 1998;77:1832-9.
  44. Fontijn-Tekamp FA, Slagter AP, Van Der Bilt A, Van THMA, Witter DJ, Kalk W, et al. Biting and chewing in overdentures, full dentures, and natural dentitions. *J Dent Res.* 2000;79:1519-24.
  45. Rismanchian M, Bajoghli F, Mostajeran Z, Fazel A, Eshkevari P. Effect of implants on maximum bite force in edentulous patients. *J Oral Implantol.* 2009;35:196-200.
  46. Mancuso DN, Goiato MC, Gennari Filho H, Gomes EA. Bite force and masticatory efficiency in implant-retained dentures: literature review. *Dent Today.* 2008;27:56-8.
  47. Luraschi J, Schimmel M, Bernard JP, Gallucci GO, Belser U, Muller F. Mechanosensation and maximum bite force in edentulous patients rehabilitated with bimaxillary implant-supported fixed dental prostheses. *Clin Oral Implants Res.* 2012;23:577-83.