Turkish Journal of Geriatrics
2015;18(1):75-80

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RESEARCH

THE EFFECT OF IMPLANT THERAPY ON MAXIMUM BITE FORCE IN EDENTULOUS ELDERLY PATIENTS: AN IN VIVO STUDY

ABSTRACT

Introduction: The purpose of the present study was to compare the bite force differences between conventional complete denture prostheses and implant retained overdentures.

Materials and Method: The study group consisted of 15 complete denture patients. Three months after insertion of conventional dentures, the first bite force measurements were made with a Dental Prescale sheet (Fuji Film, Tokyo). After 5 and 7 weeks, two implants were placed in the mandibular symphysis region. Three months after implant surgery, implant retained overdentures were fabricated. Three months after the insertion of implant retained overdentures, a second set of bite force measurements was made and the values were recorded. Bite forces were compared between conventional complete dentures and implant retained overdentures and the chewing satisfaction obtained from patients in both groups was measured using visual analogue scale. All results were evaluated statistically using a paired t-test and values of $p<0.05$ were considered as statistically significant.

Results: Bite forces and chewing satisfaction increased in all patients after the implant retained overdenture insertion. The mean bite force values before and after implant therapy were found 194.03±95.08 Newton and 302.91±119.84 Newton respectively. According to the paired t-test, a statistically significant difference were found in bite forces and chewing satisfaction before and after implant therapy ($p<0.05$).

Conclusions: The present study showed increased bite forces and chewing satisfaction after insertion of implant retained overdentures.

Key Words: Denture, Overlay; Bite Force; Dental Implants.

ARAŞTIRMA

DİŞSİZ YAŞLI HASTALARDA İMPLANT TEDAVİSİNİN MAKSİMUM ISIRMA KUVVETİ ÜZERİNE ETKİSİ

ÖZ

Giriş: Bu çalışmanın amacı, implant destekli tam protez ile konvansiyonel tam protezler arasındaki ısırma kuvvetleri farklılıklarının karşılaştırılmasıdır.

Gereç ve Yöntem: Çalışmaya 15 dişsiz hasta dahil edildi. Konvansiyonel protez yapıldıktan 3 ay sonra, Dental Prescale (Fuji Film, Tokyo) kullanarak ilk ısırma kuvvet kayıtları alındı. 5 ila 7 hafta sonra alt çene simfiz bölgesine iki adet implant yerleştirildi. Implant cerrahisinden üç ay sonra, implant destekli protezler yapıldı. Bu protezler üç ay kullandırıldıktan sonra ikinci ısırma kuvvet kayıtları alındı ve değerler kaydedildi. İmplant destekli ve konvansiyonel tam protezler arasındaki ısırma kuvvetleri ile, her iki gruptaki hastalardan visual analog skala kullanılarak elde edilen çiğneme memnuniyeti karşılaştırıldı. Tüm sonuçlar eşleştirilmiş t-testi ile değerlendirildi ve p'nin 0.05 değerinden küçük olması istatistiksel olarak anlamlı olarak kabul edildi.

Bulgular: İmplant yerleştirilmesi sonrası tüm hastalarda ısırma kuvveti ve çiğneme memnuniyeti arttı. İmplant öncesi ve sonrası ortalama ısırma kuvveti sırasıyla 194,03±95.08 Newton ve 302.91±119,84 Newton bulundu. Eşleştirilmiş t-testi'ne göre implant öncesi ve sonrası ısırma kuvveti ve çiğneme memnuniyeti açısından anlamlı fark bulundu ($p<0,05$).

Sonuç: Bu çalışma implant destekli protez sonrası ısırma kuvvetinin ve çiğneme memnuniyetinin arttığını gösterdi.

Anahtar Sözcükler: Mandibular Dişsizlik; Maksimum Isırma Kuvveti; Dental İmplant.

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Received: 24/10/2014

Accepted: 13/01/2015

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Introduction

Although complete denture prosthesis is a widely used prosthodontic treatment option in dentistry, oral rehabilitation using a conventional complete denture, even if it is correctly executed, may not fully resolve the functional and psychological problems of edentulous patients. Complete denture wearers often complain about reduced bite force, mobility, retention-stability problems and pain (1). In addition, masticatory performance, treatment success, patient satisfaction, and oral health-related quality of life are important factors in prosthodontic treatment (2,3).

According to Fontijn-Tekamp (1), the reasons for decreased bite forces are multifactorial: they include individual muscle force, degree of mouth opening, tilting of the denture, and pain in the denture-bearing tissues. When pain limits oral functions, the extra degree of support for mandibular dentures afforded by dental implants could be important for improving oral function (1,4-5). For this reason, implant retained mandibular overdenture treatment has been a successful treatment modality in this group of patients and implant retained overdentures have been increasingly accepted as an alternative to conventional dentures for the oral rehabilitation of edentulous patients (6,7).

Stabilizing the denture by means of osseointegrated implants has been found to enhance masticatory performance (8-10). This finding has been reinforced by studies that compared patients' perceptions of function related to mastication with conventional and implant retained overdentures (11,12). According to a previous study, increases in masticatory efficiency can be obtained about 6 weeks after insertion of the new complete dentures (13).

Improvement of oral function after implant treatment was also demonstrated by objective methods. The maximum bite force of subjects with mandibular overdentures supported by implants was 60–200% higher than that of subjects with conventional dentures (14,15). A previous study reported that implant type and attachment systems for mandibular implant retained overdentures were found to have no effect on masticatory performance (16).

Many studies have evaluated the masticatory performance of conventional complete denture prostheses versus implant retained overdentures (17-19). Some research has shown that objective masticatory performance significantly improved after implant treatment (20,21). Investigators have suggested that occlusal contact area, occlusal pressure and bite force could be useful in understanding masticatory performance in patients (22). When the related literature was evaluated, it was found that different researchers used different devices for evaluating masticatory performance (5). Recently, Miyaura et al. (23) used a pressure detecting sheet in an epidemiological study to evaluate the bite abilities of individual patients (bite pressure, bite force and occlusal contact area).

The purpose of the present study was to compare bite force and chewing satisfaction differences in patients with conventional complete denture prostheses and then with implant retained overdentures. The research null hypothesis was that implant retained overdentures do not improve the bite force and chewing satisfaction when compared with conventional complete dentures.

Materials and Method

The study group consisted of 15 complete denture patients (10 males and 5 females; age range 55-80 years, mean age 66.4±8.7) that applied to Ondokuz Mayıs University, Faculty of Dentistry, Department of Oral and Maxillofacial Surgery and Prosthodontics. All participants received oral and written information about the trial before giving their written and informed consent to participate. This clinical trial was approved by the local ethical review board. First, a set of conventional complete dentures was prepared for each patient by the same prosthodontist. Three months after insertion of the conventional dentures, the first bite force values were recorded with a Dental Prescale sheet (Fuji Film Co, Tokyo, Japan) (Fig 1). Five to 7 weeks later, two implants were placed into the mandibular symphysis region for each patient (3.8 mm diameter and 10.5 mm length, BioHorizons®, Birmingham, USA). All surgical procedures were performed under local anesthesia by the same surgeon. Ten days after implant surgery the sutures were removed and complete dentures were adjusted by applying a soft relining material (Ufi Gel P, Voco GmbH, Germany). Two weeks after implant placement, patients started to use the dentures.

Three months from the time of implant surgery, the complete dentures that had been adjusted by applying soft relining material were removed and new implant retained complete overdentures with two ball attachments were fabricated. Three months after insertion of the implant retained complete overdentures, second bite force values were recorded. All the procedures such as application of soft relining material, insertion of the first set of complete dentures and, after the implant surgery, insertion of the second set of complete dentures, and all bite force records were completed by the

Figure 1— Pressure sensitive sheet (Dental Prescale).

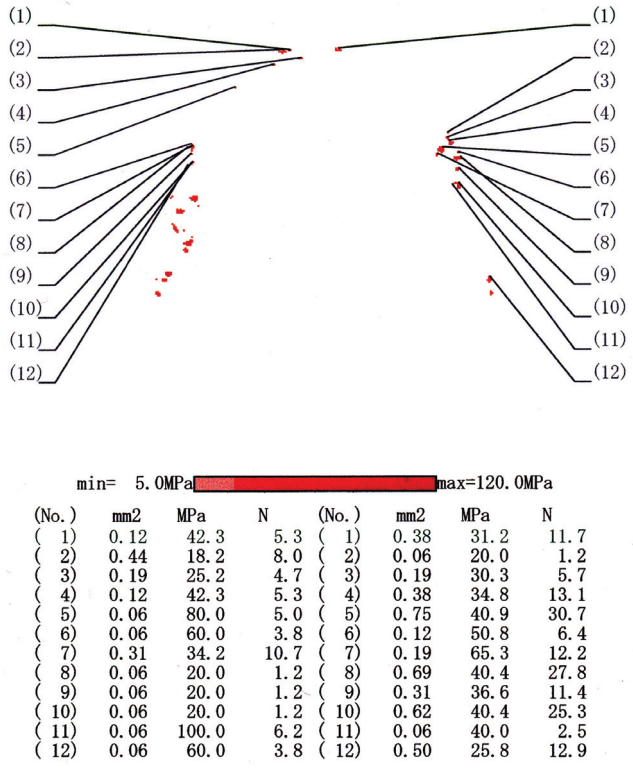

Figure 2— Example of the form of analysis of occlusal contact area (mm2), occlusal pressure (MPa) and bite force (N)

same prosthodontist. All information collected from the patients' records was blinded by numbering it from 1 to 30. The occlusal pressure records were then sent to another investigator to calculate the bite force using the Dental Prescale Occluzer System (Fuji Film Co, Tokyo, Japan).

Bite force was measured as described by Sato et al. (24). Records were taken with subjects seated upright, looking forward, and with an unsupported natural head position. The Dental Prescale sheet was positioned on the teeth by the prosthodontist and the subject was instructed to bite as forcefully as possible. Before positioning the sheet, all the patients were trained to bite down in the maximum intercuspal position by the same prosthodontist.

The Dental Prescale consists of two paper sheets with numerous microcapsules containing a red dye between them. When the teeth are brought into occlusion, these microcapsules rupture and discharge the dye, staining one of the papers red. The density of the color is in proportion to the degree of pressure applied (24). Bite force and occlusal contact area were calculated from the degree of coloring. Tooth contact area and the density of the color for the occlusal pressure recorded on the Dental Prescale sheet were measured by an Occluzer; the bite force was also calculated using this apparatus. The occlusal contacts were detected by this chemical reaction and scanned by the occlusion pressure graph (Figure 2). The mean bite force values before and after implant therapy are listed in Table 1.

Chewing satisfaction of all patients was measured using visual analogue scale (VAS). Before both bite registration, patients marked the level of their chewing efficiency on a 100 mm, non-hatched visual analogue scale. According to this scale, the level of chewing efficiency was documented in the range of 0–10 numerically and verbally as no chewing (0), low chewing satisfaction (1-3), moderate chewing satisfaction (4-6) and high chewing satisfaction (7-10).

Table 1— Mean Bite Force (Newton) of Patients Before and After Implant Therapy.

	Before	After
Bite Force	194.03[a] ± 95.08	302.91[b] ± 119.84

*Values having same letters were not significantly different for Student t test (p>0.05)

With in each group, values were averaged. In this study, all the data were transferred to SPSS software (release 12.0; SPSS, Chicago, Ill) for analysis. The Kolmogorov-Simirnov test showed that the data had a normal distribution ($p>0.05$).

Results

Biting force and chewing satisfaction increased in all patients after the implant retained overdentures were inserted. The mean bite force values before and after implant therapy were found 194.03±95.08 Newton (N) and 302.91±119.84 N respectively. Bite force values before and after implant therapy are listed in Table 1. According to the paired t-test, a statistically significant difference was found in bite forces before and after implant therapy ($p=0.004$).

The chewing satisfaction obtained from patients in both groups was measured using VAS. The mean values and standard deviations of chewing satisfaction are presented in Table 2. The mean chewing satisfaction of patients after implant therapy (7.2±1.21) was significantly higher than the values before implant therapy (3.73±1.39). According to the paired t-test, a statistically significant difference was found in chewing satisfaction before and after implant therapy ($p=0.001$).

Discussion

The objective results of this study reject the null hypothesis. Implant retained overdentures increased the bite force values. This study's results are in agreement with previous studies. The present study showed that biting force and chewing satisfaction increased significantly for implant retained complete overdentures, compared to conventional complete dentures. Subjective patient-based outcomes, including ratings by patients of masticatory ability, food preferences, satisfaction with treatment, and oral health-related quality of life, have been increasingly recognized as critical outcomes for prosthodontic treatment (2,3). However, there is a need to validate patients' perception of changes, or lack of changes, in masticatory function with new implant retained overdentures. In fact, it has been repeatedly shown that the relationship between objective measures of masticatory performance and perceptional estimates of masticatory ability are weak in patients wearing conventional dentures (9) and implant retained dentures (10).

In this study, the chewing satisfaction obtained from patients in both groups was measured using VAS. The level of chewing satisfaction was documented in the range of 0–10 numerically and verbally as no chewing (0), low chewing satisfaction (1-3), moderate chewing satisfaction (4-6) and high chewing satisfaction (7-10). While patients have indicated that low chewing satisfaction before implant therapy, they have indicated that high chewing satisfaction after implant therapy.

A previous study concluded that biting abilities improved 2 months after insertion of new prostheses (13). In this study, a significant increase in masticatory efficiency was observed about 6 weeks after insertion of the new complete dentures. Other researchers have stated that a significant increase in bite force can be seen 10 months after the insertion of implants (1). In this study, bite force measurements were taken three months after the insertion of the complete dentures and the second measurements were taken three months after the insertion of the implant retained overdentures.

Some researchers have reported a significantly higher bite force for men (N=190) than for women (N=114) (1,25). Therefore equal numbers of men and women were an important factor in their study. However, in this present study, using a within-subjects design, bite force measurements were made before and after insertion of the dentures and bite force changes were evaluated for each patient.

In general, it is difficult to compare bite force studies due to differences in methodology. First, different types of measuring devices have been used in the past. For example, the most commonly used devices are piezoelectric elements or miniature strain gauges. However, positioning these devices along the dental arch may cause some unexpected results in bite force measurement (5). Second, differences in physical properties, such as the thickness of measuring devices, may affect biting abilities. Previous investigators have reported that the thickness of the device limits bite force (5,25). Biting on a 14-mm thick device results in higher bite forces than biting on a 10-mm-thick device (5) for healthy young adults of comparable age. In the present study, utilizing pressure detecting sheets avoided the device thickness problem. However, the differences between bite forces may also be caused by differences in muscle force, degree of mouth opening, pain experien-

Table 2— Chewing Satisfaction Values of Patients Before and After Implant Therapy

	Before	After
Bite Force	3.73[a]±1.39	7.20[b]±1.21

*Values having same letters were not significantly different for paired t test ($p>0.05$)

ced, or tilting of the dentures (4). Furthermore, there are differences between patient groups studied with regard to age, numbers of participants, and the male-to-female ratio. In many studies, this information is missing, which makes a reliable comparison difficult (1).

A previous study reported that mandibular residual ridge height is a critical factor relative to masticatory performance of complete dentures. When patients with an average mandibular residual ridge height were enrolled, no advantages in masticatory performance with implant retained overdentures compared to new complete dentures were found (7). In this study, based on the patient's panoramic radiographs, all the patients had a highly resorbed mandibular residual ridge.

Factors such as denture stability and the presence of pain in denture-bearing areas have been shown to affect masticatory performance and bite force. When these limiting factors exist, the degree of support of mandibular dentures by dental implants could be important for improving the function (1).

A review of the relevant literature showed that the type of implant and attachment system for mandibular implant retained dentures were found to have no effect on masticatory performance (16), so in this study the effects of different implant types or attachment systems on masticatory performance were not evaluated.

In conclusion, the results of the present study indicated that mandibular implant retained overdenture treatment, as opposed to conventional complete dentures, resulted in significantly better biting force and chewing satisfaction values. From a clinical standpoint, these results show that the advantages of implant retained mandibular overdentures were significant and that their wider application should be recommended.

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