Libyan Journal of Science & Technology 14:1 (2022) 38-43

Faculty of Science - University of Benghazi

Libyan Journal of Science & Technology

journal home page: www.sc.uob.edu.ly/pages/page/77

Evaluation of the dietary outcomes among middle-aged Libyan edentulous male subjects treated with complete dentures; Part 1: The perceived ability to chew.

Gamal G. Burawi*, Rabie M. El huni, Amel M. Lefsaay, Warida A. Elnaihoum, Isaeida A. Mohammed, Faraj A. Ali

Department of Removable Prosthodontics, Faculty of Dentistry, University of Benghazi

Highlights

- **Chewing efficiency of locally favourite meals was evaluated using a structured questionnaire answered by a sample of Libyan edentulous individuals treated with conventional complete dentures.**
- **The results verified that the perceived ability to chew is significantly improved for almost all food tested.**
- **Rehabilitation with conventional complete dentures along with vigorously education programs about healthy nutritional diets are advised.**

ARTICLE INFO

Article history:

Received 16 September 2021
Revised 20 March 2022
Accepted 22 March 2022

Keywords:

Edentulism, Diet, Chewing, Complete Denture Quality.

**Address of correspondence:*

E-mail address: gamal.burawi@uob.edu.ly

G. G. Burawi

ABSTRACT

Statement of problem: The implant-retained or supported overdentures have been indicated as the primary treatment of edentulousness. However, for obvious reasons fewer patients will afford this type of treatment. Therefore, it is desirable to investigate and re-establish the effectiveness of the provision of complete dentures on patients' essential oral functions.

Aim of the study: To assess the perceived chewing ability of edentulous Libyan patients rehabilitated with traditional complete dentures.

Materials and methods: Thirty-five edentulous adult male patients were carefully selected for this clinical trial. The researchers interviewed all subjects and assisted them in filling accurately the visual analogue scale questionnaire (VAS). The VAS questionnaire contained efficiency-rating questions assessing the effectiveness of wearing complete dentures on the ability to chew seven locally favourite meals. The answer for each question was ranked from zero to 100. Then, a standard treatment procedure was performed to provide each subject with a conventional complete denture. At the recall visit scheduled after six months of post-insertion of all prostheses, the same researchers helped subjects to indicate again their satisfaction level with their complete dentures using the same practice VAS questionnaire. The VAS scores recorded pre-treatment were compared to those scores recorded post-treatment using Wilcoxon signed-rank tests.

Results: All subjects verbally expressed their contentment and enjoyment when eating meals using their dentures. The perceived ability to chew was significantly improved for almost all food tested except for those, which require slicing before chewing. The conventional complete dentures still provide edentulous patients with an improved chewing ability when consuming traditional Libyan meals.

Conclusion: An optimistic improvement of chewing ability with complete dentures is achieved as shown by the validated practice VAS questionnaire. Consequently, the treatment with traditional complete dentures can be generalized and used for wider edentulous patients seeking treatment in the Libyan general dental practice.

1. Introduction

Full mouth rehabilitation with implant-retained overdentures is highly advised as the primary treatment of edentulism (Thomason *et al*., 2009). However, various medical conditions and financial resources are considered common barriers against treatment with implant overdentures. Additionally, recent studies with long-term follow-up concluded that improvements in patient satisfaction gained with implant-retained over-dentures are not essentially higher than those obtained with complete dentures. Therefore, conventional complete dentures are still considered a valid treatment of complete edentulism (Carlsson and Omar 2010; Sivaramakrishnan and Sridharan 2016). The treatment of edentulousness with traditional complete dentures is simple**,** does not requires any invasive surgery, and is cost-effective. However, the majority of treated edentulous patients complained of a lack of stability and retention which, consecutively caused less bite force and inability to chew hard food, as a result, edentulous subjects show potential dietary limitations (Okamoto *et al*., 2019; Schimmel *et al*., 2015) There well-accepted fact authenticated by previous studies which is the perceived chewing ability of complete denture wearers is significantly less than those of dentate subjects (Tripathi *et al*., 2014; Slagter *et al*, 1993) and the reduced masticatory ability is directly connected with the advancement of age as well a the dental status of the subjects (Chong, *et al*., 2016)**.** Furthermore, improving the quality of complete dentures or constructing new complete dentures does not fully enhance the masticatory performance and chewing ability in edentulous patients (Slagter *et al*., 1992)**.** Medical investigations presented significant credievidencences connected dietary imbalance to a range of systemic health disorders like increased risk of high blood pressure, cardiovascular disease,

 ISSN: Online 2663-1407, Print 2663-1393; National Library of Libya, Legal number: 390/2018

and esophageal, gastric, and bowel cancers (Ritchie *et al*., 2002; De Angelis *et al*., 2018). Several factors contribute to patient satisfaction with complete denture therapy. These factors are related to the prosthodontist, the therapy chosen, the technique used, and to factors that are directly associated with the patient. Meanwhile, there is deficient evidence to support that nutritional state relates to dental status alone, consequently; the dental status of an edentulous patient might be categorized as a contributing a co-factor to the outcome of any prosthetic management (Smith and McCord 2004; Kovač *et al*., 2012; Bashayer and Salma 2016; Cerutti *et al*., 2017). The majority of these factors were overwhelmingly investigated when the outcome of wearing implant-supported complete dentures was compared to those of the complete dentures. However, fewer studies explored the improvements in dietary intake after treatment with complete dentures (Shinkai *et al*., 2002). These comparisons exploited different parameters of the deprived nutritional status including dietary intake patient's food diaries, ability to chew, and chewing function (Allen and McMillan 2002; Geckili *et al*., 2012). In dentistry, the subjective approach is commonly used to investigate the oral health perceptions of a population by questioning the subjects and then using their self-rated health condition to summarize health status symptoms or disability. Masticatory efficiency is usually evaluated by using subjective measurements of the masticatory ability of the subject to chew test food. While the masticatory performance is investigated by utilizing specific measures like food particle size, the number of chewing strokes, and the bite force essential to grind food to a smaller particle sizing subjective assessment of masticatory ability is more efficient when focused subjective structured questionnaires are used to evaluate the subjects' own opinion regarding their perceived ability to chew test food. The only drawback of this assessment is the ascendency of food preferences in the subjects' responses (Allen and McMillan 2003a). Recent clinical trials on the treatment of edentulousness are mainly concentrated on implant therapy while the lacking clinical evidence extensively influences the provision of complete dentures. As the patient perceptions and the impact of complete denture treatment are fundamental for improving patients' quality of life as well as satisfaction, thus studies designed to assess patient feedback on treatment outcomes are very essential (Heydecke *et al*., 2003; Awad *et al*., 2003).

Currently, there is no study carried out in Libya investigating the functional limitations of the complete denture provision. Thus, the objective of this series of studies is to start by assessing the effectiveness of conventional complete dentures on patients' perceived ability to chew traditional Libyan meals in the region of Benghazi City.

2. Materials and methods

This clinical trial was conducted at the clinic of the Department of Prosthodontics, Faculty of Dentistry-University of Benghazi-Libya. The authors received full ethical approval from the Ethics Committee of the Faculty of Dentistry. Complete edentulism is regarded as a true chronic condition and each edentulous patient has a unique dental history and management. In addition, the chewing process is related to occlusal schemes, and the occlusal form of the artificial teeth, which both are simple to achieve and control within subjects. Moreover, the treatment with complete dentures is relatively short and no "washout" period is required because of the rapid disappearance of dentures effects upon removal from the mouth. Therefore, based on the previously mentioned facts, the non-randomized subject's trial design with two data collection periods was selected for the current study. The period (six months) chosen to wear complete dentures by subjects is adequate to develop and improve patients' physiological and psychological adaptations to their complete dentures. In this study, the data collected at base baseline treatment) is compared to those collected at post-treatment (post-insertion) with complete dentures prescribed for the edentulous patients. To reduce patients' orientation toward rating on a comparison basis, the practice (VAS) was used to investigate subjects' perceived ability to chew food after the insertion of complete dentures. The practice visual analogue scale (VAS) or category scales (CAT) have been authenticated and used in previous clinical trials to evaluate the influence of prostheses on various aspects of patient satisfaction (De Grandmont *et al*., 1994; Daly *et al*., 2003; Feine *et al*., 1998; Siriwardena and, Gillam, 2014). Practice (VAS) is a 100 mm length horizontal line calibrated from zero marked by (not all satisfied) to 100 and marked by (extremely satisfied). The patient is required to draw a vertical line at the point on the horizontal line that best represents his/her most answer strength. The higher score indicates more satisfaction and the lower score indicates less satisfaction. The practice visual analogue scale (VAS) is shown in Fig. 1.

ASSESSMENT OF COMPLETE DENTURE SATISFACTION (VAS) QUESTIONNAIRE

Patient's name:……Age:…..File no:…Contact no.:…date of denture insertion:……..

WHERE YOU THINK YOUR ANSWER ACCURATELY FITS, PLEASE LAY DOWN A VERTICAL LINE ACROSS THE HORIZONTAL LINE PROVIDED BENEATH EACH QUESTION.

A. ABILITY TO CHEW

Please indicate how difficult it is for you to eat **fresh white bread**.
Extremely difficult _____ Not at all difficult □□□

Please indicate how difficult it is for you to eat **stewed pasta**.
Extremely difficult _____ Not at all difficult □□□

Please indicate how difficult it is for you to eat **stuffed vegetables.**
Extremely difficult _____ Not at all difficult □□□

Please indicate how difficult it is for you to eat **stewed chicken.**
Extremely difficult _____ Not at all difficult □□□

Please indicate how difficult it is for you to eat raw **tomatoes.**
Extremely difficult _____ Not at all difficult □□□

Please indicate how difficult it is for you to eat raw **cucumber.**
Extremely difficult _____ Not at all difficult □□□

Please indicate how difficult it is for you to eat raw **apple.**
Extremely difficult _____ Not at all difficult □□□

Fig. 1. The denture satisfaction questionnaire (VAS) was used in this study.

Edentulous patients referred to the undergraduate student clinic for the provision of conventional complete dentures were asked to participate in the study. All patients submitted official written consents; then each patient underwent history taking and clinical examination procedures to assess his eligibility for the complete denture treatment. Thirty-five subjects fulfilled the inclusion criteria; age ranged from 35 to 65 years (median 54 years), edentate for at least six months, no history of previous partial or

complete dentures, good general medical condition, adequate maxillary and mandibular alveolar bones without the need for any pre-prosthetic surgery, and the ability to communicate properly with the interviewer. To counteract the effect of gender on the results of this study, female edentulous subjects were excluded as female edentulous subjects produce less biting force; therefore, they dislodge their complete dentures less frequently compared to their male counterpart (Palinkas *et al*., 2010). All subjects were presented with demonstrations about answering accurately each question of the practice (VAS) questionnaire until they were able to complete the achievable denture ratings with a numerical sequence from zero (minimum and worst result) to 100 (maximum and optimum result). Then and before the commencement of treatment, each subject answered the practice (VAS) questionnaire which is commonly used when assessing patients' satisfaction with complete dentures focusing on the chewing ability. The practice (VAS) questionnaire is extensively used due to its high accuracy in detecting changes between groups (Allen and McMillan, 2003b). This instrument contained intense questions on the consistency of the dietary intake of different test food. Subjects were requested to rate their difficulty in chaining a range of test food on a graded practice VAS scale from Zero ('extremely difficulty') to 100mm ('Not at all difficult'). The wording of each question was on the first part entitled ability to chew food (*How difficult it is to chew*). Then, all standard simplified technique treatment was performed by one prosthodontist (G.B.) to produce the conventional maxillary and mandibular complete dentures (primary & final impressions, horizontal and vertical jaw relations, mounting on an average setting articulator, using the bilaterally balanced occlusion scheme in the setting of semi-anatomical acrylic teeth, trial denture try-in, insertion, and adjustments (Nuñez *et al*., 2015). One experienced senior dental technician was assigned to construct the final prostheses utilizing the traditional laboratory procedures. Upon denture delivery, post-insertion instructions were explained to each patient. The first recall appointments were scheduled to perform any corrections of the dentures if required. To improve denture adaptation and comfort for patients, some areas of the anatomic surface of the denture bases were relieved. Subjects wore the complete dentures for six months, and then at the follow-up visit, each subject completed the final practice (VAS) questionnaire. The food data comparison covered only seven tests food to minimize the influences of dietary restrictions and food preference on patients' ratings. The seven test food types were selected from a list of most popular home-cooked meals according to the results of a dietary survey carried out among the employees and patients attending the Faculty of Dentistry clinics in Benghazi. This list was then customized to resemble the list of test food categorized according to the extent of masticatory difficulty by Swedish patients wearing conventional dentures (Bergman and Carlsson, 1972). The seven food types chosen for this study were fresh white bread, pasta, stuffed vegetables, stewed chicken, raw tomatoes, raw cucumber, and raw apple.

3. Statistical analysis

The estimated sample size for this study was (n=35) to provide a 90% power based on a previously published study of edentulous patients treated with conventional dentures (Allen, 2005). To eliminate the risk of bias and for errors crosscheck, two reviewers independently measured and summed normatively each patient's practice VAS questionnaire data recorded during the two periods. Then text and tables were used to transfer the data onto a spreadsheet, which was entered for analysis into the Statistical Package for Social Sciences (SPSS) for Windows: Version 19.0. Fix Pack. The primary outcome variable was the patients' ratings on the practice VAS scale recorded at two periods pre-treatment and post-treatment. Descriptive statistics were described in form of means and standard deviations and quantitative percentages. Pre-treatment scores were compared to post-treatment scores using a non-parametric Wilcoxon statistical test to detect the statistical difference in patients' perceived ability to chew and chewing function before and after the treatment with complete dentures. A p-value less than 0.05 was accepted as statistically significant controlling for alpha error based on detecting a difference of 10 between pre-treatment and post-treatment practice VAS scores.

4. Results

The patients' ratings of their ability to chew before and after treatment are illustrated in (Table 1 & Fig. 2). The patients' scores of their perceived chewing ability during the transition from pre-treatment to post-treatment with complete dentures demonstrated significant improvements for most of the food types that were tested. Improvement was only not significant for the ability to chew raw cucumber and raw apple.

Table 1

Mean differences between subjects' perceived chewing ability scores comparing pre-treatment and post-treatment.

▼TESTED FOOD	ABILITY TO CHEW		
	(*TRANSITION FROM PRE-TREATMENT TO POST-TREATMENT*) MEAN DIFFERENCE ±SD	95% CI	P-VALUE
BREAD	19.50 ±25.68	04.28, 32.72	**0.014**
STEWED PASTA	18.87 ±29.67	00.88, 34.85	**0.041**
STUFFED VEGETABLES	21.25 ±33.32	02.08, 38.92	**0.032**
STEWED CHICKEN	25.71 ±36.80	-47.39, -6.04	**0.015**
RAW TOMATOES	28.47 ±46.70	05.77, 55.17	**0.019**
RAW CUCUMBER	05.33 ±52.13	-60.09, 51.43	0.850
RAW APPLE	09.75 ±25.12	-30.22, 49.72	0.494

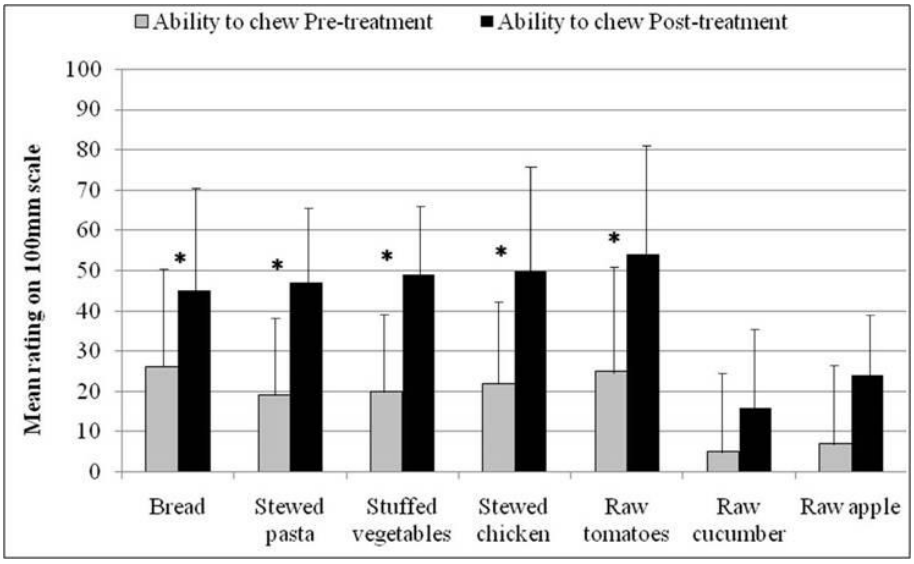

Fig. 2. Histogram showing mean subjects' perceived chewing ability scores for pre-treatment and post-treatment. (* = $p<0.05$).

5. Discussion:

It is worth mentioning that the purpose of the present study was to investigate the ability to chew and did not cover other co-factors that may influence the outcome of complete dentures. Improper chewing of food is of major importance as their consequences had deteriorating effects on the general health status of edentulous patients. Subjects recruited for this study were inexperienced edentate individuals with no history of traditional complete dentures. Furthermore, all subjects had been edentulous for a short period, and properly not adapted well to the limitations caused by the loss of their natural dentition. Most of those subjects retain more favorable residual alveolar ridges making retention and stability of their dentures more achievable than those patients do with long-standing edentulousness. Therefore, the success achieved in this study may be contributed to the good retention and stability exhibited by dentures and to the short edentate period of the edentulous participants. In addition, patients recruited for this study were aware that they would be provided with complete dentures and this probably might have boosted any bias that appeared in their judgments. Using complete dentures by edentulous subjects improved their chewing ability ratings as observed on data gathered at six months post-insertion as compared to pre-treatment ratings. These improvements confirm and add weight to the concept, which considers that traditional complete dentures are the most convenient rehabilitating prosthesis of edentulousness (Fenlon *et al*., 2000; Bellini *et al*., 2009; Goiato *et al*., 2012; Celebic *et al*., 2003). Edentulous subjects treated in this trial may show signs of a risk of poor nutritional conditions even despite their ability to chew food was noticeably improved. This might be attributed to the deficient awareness of the values of the nutritional ingredients, and poor cooking habits of healthy foodstuffs. This trend of lacking knowledge of nutritional values and subsequently the poor selection of foodstuffs could be linked to the entire population of Benghazi City as observed after analyzing the initial dietary survey conducted earlier among a sample of population living in Benghazi City. Additionally, this trial was conducted during an era of unfavorable economic circumstances affecting almost every citizen living in Libya. This issue might be considered when comparing the results of the current study to those previously published studies since the vast majority of those studies were conducted under different conditions in much wealthier western countries.

6. Conclusion

The findings of the study presented a positive enhancement of chewing ability with complete dentures as evaluated by a validated practice VAS questionnaire. Consequently, according to the results obtained in this study and supported by the literature, complete denture treatment can be generalized to a wider completely edentulous patient seeking treatment in general dental practice. The current results of this study need to be strengthened with more comprehensive study designs, which will lead to a better understanding and appreciation of the outcomes of complete denture therapy. A follow-up of this population is currently underway and may provide further important information regarding the long-term effects of complete dentures on patient chewing function and post-insertion complications.

7. Limitations of the study:

There is no precise or faultless study as the chance of missing important issues and or incorrect inclusion of a single data may occur. Furthermore, other factors; for instance denture quality, the personality of the patient, and the patient/dentist relationship were not assessed in this study. In addition, all the participants in the study were males living in Benghazi city therefore, the conclusions and implications of this study might not be specifically valid in all regions of Libya; in addition, the inclusion of female subjects may affect or change the study overall results. The generalization of the results is limited to the heat-cured acrylic resin complete dentures investigated in this study; consequently, it is not suitable to conclude that all other prostheses made of different materials will show similar results although similarities in results might be highly expected.

8. Recommendations:

The main sensible duty of the "Ministry of Health" is to afford all kinds of efficient treatments to all citizens and edentulous subjects should be included. Since the procedure of providing complete dentures is very simple, therefore it is obligatory for the ministry of health to provide suitable dental clinics and engage general dental practitioners to make the provision of complete dentures available to all edentulous populations. This will help to improve the confidence among dentists to deal with older patients and will provide dentures of high quality. The present and previous studies illustrated the lack of knowledge about healthy nutritional diets among patients subsequently; it is important to support the treatment of edentulousness with provisionally planned dietary advice (Ellis *et al*., 2010; Sarkar 2019).

Acknowledgments:

The authors are sincerely grateful to the senior dental technicians Mr. Bin Eisa Alwuheeshi and Mr. Mrad Nemer for their excellent technical work, and to all nursing personnel of the Removable Prosthodontics Department, Faculty of Dentistry, University of Benghazi, for their well-appreciated contribution.

References

Allen, F. and McMillan, A. (2002) 'Food selection and perceptions of chewing ability following provision of implant and conventional prostheses in complete denture wearers', *Clinical Oral Implants Research*, 13(3), pp. 320-326.

Allen, F. and McMillan, A. (2003b) 'A longitudinal study of quality of life outcomes in older adults requesting implant prostheses and complete removable dentures', *Clinical Oral Implants Research*, 14(2), pp. 173-179.

Allen, F. and McMillan, A. (2003a) 'A review of the functional and psychosocial outcomes of edentulousness treated with complete replacement dentures' *Journal of the Canadian Dental Association*, 69(10), pp. 662a-662e.

Allen, F. (2005) 'Association between diet, social resources, and oral health related quality of life in edentulous patients', *Journal of Oral Rehabilitation,* 32(9), pp. 623-628.

Awad, M., Lund, J., Shapiro, S., Locker, D., Klemetti, E., Chehade, A., Savard, A., Feine, J. (2003) 'Oral health status and treatment satisfaction with mandibular implant overdentures and conventional dentures: A randomized clinical trial in a senior population', *The International Journal of Prosthodontics*, 16(4), pp. 390-396.

Bashayer, Z. and Salma, A. (2016) 'Influencing Factors on Patients' Expectation and Satisfaction with Complete Denture wearers', *ECRONICON Dental Science*, 6.3(3), pp. 1316-1320.

Bellini D., Dos Santos, M., De Paula, V., Marchini, L. (2009) 'Patients' expectations and satisfaction of complete denture therapy and correlation with the locus of control' *Journal of Oral Rehabilitation*, 36(9), pp. 682-686

Bergman, B. and Carlsson, G. (1972) 'Review of 54 complete denture wearers. Patients' opinions 1 year after treatment', *Acta Odontologica Scandinavia*, 30(4), pp. 399-414.

Carlsson, G. and Omar, R. (2010) 'The future of complete dentures in oral rehabilitation. A critical review', *Journal of Oral Rehabilitation*, 37(2), pp. 143-156.

Celebic, A., Knezovic-Zlataric, D., Papic, M., Carek, V., Baucic I., Stipetic J. (2003) 'Factors Related to Patient Satisfaction With Complete Denture Therapy', *The Journal of Gerontology*, 58(10), pp. 948-953.

Cerutti-Kopplin, D., Emami E., Hilgert, J., Hugo F., Rivaldo, E., Padilha, D. (2017) 'Predictors of Satisfaction with Dentures in a Cohort of Individuals Wearing Old Dentures: Functional Quality or Patient-Reported Measures?', *Journal of Prosthodontics*, 26(3), pp. 196-200

Chong, M., Khoo, C., Goh, K., Rahman, F., Shoji, Y. (2016) 'Effect of age on bite force', *Journal of Oral Science*, 58(3), pp. 361-363.

Daly, R., Elsner, R., Allen, F., Burke, F. (2003) 'Associations between self-reported dental status and diet', *Journal of Oral Rehabilitation,* 32, 30(10), pp. 964-970.

De Angelis, F., Basili, S., Giovanni, F., Dan Trifan, P., Di Carlo, S., Manzon, L. (2018) 'Influence of the oral status on cardiovascular diseases in an older Italian population', *International Journal of Immunopathology and Pharmacology,* 32, pp. 1-7.

De Grandmont, P., Feine, J., Tache, R., Boudrias, P., Donohue, W., Tanguay, R., Lund, J. (1994) 'Within-subject comparisons of implant-supported mandibular prostheses: psychometric evaluation', *Journal of Dental Research*, 73(5), pp. 1096-1104.

Ellis, J., Elfeky, A., Moynihan, P., Seal, C., Hyland R., Thomason, M. (2010) 'The impact of dietary advice on edentulous adults' denture satisfaction and oral health-related quality of life 6 months after intervention', *Clinical Oral Implants Research*, 21(4), pp. 386-391.

Feine, J., Awad, M., Lund, J. (1998) 'The impact of patient preference on the design and interpretation of clinical trials', *Community dentistry and oral epidemiology*, 26(1), pp. 70-74.

Fenlon, M., Sherriff, M., Douglas, J. (2000) 'An investigation of factors influencing patients' use of new complete dentures using structural equation modeling techniques', *Community dentistry and oral epidemiology*, 28(2), pp. 133-140.

Geckili, O., Bilhan, H., Mumcu, E., Dayan, C., Yabul, A., Tuncer, N. (2012) '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', *Special Care in Dentistry*, 32(4), pp. 136-141.

Goiato, M., Bannwart, L., Moreno, A., Dos Santos, D., Martini, A., Pereira, L. (2012) 'Quality of life and stimulus perception inpatients' rehabilitated with complete denture', *Journal of Oral Rehabilitation*, 39(6), pp. 438-445.

Heydecke, G., Boudrias, P., Awad, M., De Albuquerque, R., Lund, J., Feine, J. (2003) 'Within-subject comparisons of maxillary fixed and removable implant prostheses: Patient satisfaction and choice of the prosthesis', *Clinical Oral Implants Research*, 14(1), pp. 125-130.

Kovač, Z., Troskot, Z., Uhač, I., Cabov, T., Lajnert, V., Kovačević, D., Filipović-Zore, I., Tariba, P. (2012) 'Multivariate analysis of different factors affecting the patient general satisfaction with complete dentures', *Collegium Antropologicum*, 36(3), pp. 791-794.

Nuñez, M., Silva, D., Barcelos, B., Leles, C. (2015) 'Patient satisfaction and oral health-related quality of life after treatment with traditional and simplified protocols for complete denture construction', *The Journal of Gerontology*, 32(4), pp. 247-253.

Okamoto, N., Amano, N., Nakamura, T., Yanagi, M. (2019) 'Relationship between tooth loss, low masticatory ability, and nutritional indices in the elderly: A cross-sectional study', Biomedcentral Oral Health, 19(1), pp. 110-120.

Palinkas, M., Nassar, M., Cecílio, F., Siéssere, S., Semprini, M., Machado-de-Sousa, J., Hallak, J., Regalo, S. (2010) 'Age and gender influence on maximal bite force and masticatory muscles thickness', *Archives of Oral Biology*, 55(10), pp. 797–802.

Ritchie, C., Joshipura, K., Hung, H., Douglass, C. (2002) 'Nutrition as a mediator in the relation between oral and systemic disease: associations between specific measures of adult oral health and nutrition outcomes', *Critical Reviews in Oral Biology & Medicine*, 13(3), pp. 291-300.

Sarkar, A. (2019) 'Oral processing in elderly: Understanding eating capability to drive future food texture modifications', *Proceedings of the Nutrition Society*, 78(3), pp. 329–339.

Schimmel, M., Katsoulis, J., Genton, L., Müller, F. (2015) 'Masticatory function and nutrition in old age', *Swiss Dental Journal*, 125(4), pp. 449–454.

Shinkai, R., Hatch, J., Rugh, J., Sakai, S., Mobley, C., Saunders, M. (2002) 'Dietary intake in edentulous subjects with good and poor quality complete dentures', *Journal of Prosthetic Dentistry*, 87(5), pp. 490-498.

Siriwardena, A. and Gillam, S. (2014) 'Patient perspectives on quality', *Quality in Primary Care*, 22(1), pp. 11-15.

Sivaramakrishnan, G. and Sridharan, K. (2016) 'Comparison of implant supported mandibular overdentures and conventional dentures on quality of life: a systematic review and meta-analysis of randomized controlled studies', *Australian Dental Journal*, 61(4), pp. 482-488.

Slagter, A., Bosman, F., Van der Glas, H., Van Der Bilt, A. (1993) 'Human jaw-elevator muscle activity and food comminution in the dentate and edentulous state', *Archives of Oral Biology*, 38(3), pp. 195-205.

Slagter, A., Olthoff, L., Bosman, F., Steen, W. (1992) 'Masticatory ability, denture quality, and oral conditions in edentulous subjects', *The Journal of prosthetic dentistry*, 68(2), pp. 299-307.

Smith, P. and, McCord, J. (2004) 'What do patients expect from complete dentures?' *Journal of dentistry,* 32(1), pp. 3-7.

Thomason, M., Feine, J., Exley, C., Moynihan, P., Müller, F., Naert, I., Ellis, J., Barclay, C., Butterworth, C., Scott, B., Lynch, C. (2009) 'Mandibular two implant-supported overdentures as the first choice standard of care for edentulous patients-the York Consensus Statement', *British dental journal,* 207(4), pp. 185-186.

Tripathi, G., Rajwadha, N., Chhaparia, N., Sharma, A., Anant, M. (2014) 'Comparative evaluation of maximum bite force in dentulous and edentulous individuals with different facial forms', *Journal of Clinical and Diagnostic Research*, 8(9), pp. 37-40.