

Factors associated with mandibular movement and vertical dimension of occlusion in elderly complete-denture wearers

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ABSTRACT

Objective: This study evaluated the effect of age, duration of edentulism, and duration of current complete-denture use on the extent of mandibular movements and on reestablishment of vertical dimension of occlusion in elderly complete-denture wearers.

Methods: Thirty volunteers were selected based on predetermined inclusion criteria. Extent of mandibular movements was assessed using intraoral Gothic arch tracings while the study participants were still wearing their old complete dentures (T0). Change in vertical dimension of occlusion was determined from measurements taken using frontal images, acquired before substituting the old dentures (T0) and seven days after the last appointment for adjusting the new complete dentures (T1). Statistical analyses were performed using Pearson correlation coefficient and one-way analysis of variance with a post hoc Bonferroni test ($\alpha = 0.05$).

Results: Pearson correlation analysis found statistically significant negative correlation between vertical dimension of occlusion and mandibular movement measurements and age and between vertical dimension of occlusion and mandibular movement measurements and duration of denture use. The Bonferroni test detected differences for all parameters evaluated, except between duration of edentulism and extent of mandibular movement.

Conclusion: The study findings show that older age and long-term use of dentures were linked to limited reestablishment of vertical dimension of occlusion and range of mandibular motion. However, the effect of duration of edentulism was not clear.

Keywords: Mouth, edentulous; Elderly; Denture, complete; Dental occlusion.

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Fatores associados com movimentos mandibulares e dimensão vertical de oclusão em idosos usuários de prótese total

RESUMO

Objetivo: Este estudo avaliou o efeito de idade, tempo de edentulismo e tempo de uso da atual prótese total na extensão dos movimentos mandibulares e restabelecimento da dimensão vertical de oclusão em idosos usuários de prótese total.

Metodologia: Trinta voluntários foram selecionados a partir de critérios de inclusão predeterminados. A extensão de movimentos mandibulares foi avaliada usando o registro intraoral do arco gótico de Gysi enquanto os participantes do estudo ainda usavam suas antigas próteses totais (T0). Alteração na dimensão vertical de oclusão foi determinada a partir de medidas realizadas em imagens frontais, obtidas antes da troca da prótese antiga (T0) e sete dias após o último ajuste da nova prótese (T1). Análise estatística foi realizada usando coeficiente de correlação de Pearson e análise de variância de uma via seguida do teste de Bonferroni ($\alpha = 0,05$).

Resultados: A análise de correlação de Pearson encontrou uma correlação negativa estatisticamente significativa entre dimensão vertical de oclusão e movimentos mandibulares e idade, e entre dimensão vertical de oclusão e movimentos mandibulares e tempo de uso da dentadura. O teste de Bonferroni encontrou diferenças estatísticas para todos os parâmetros avaliados, exceto entre tempo de edentulismo e amplitude de movimentos mandibulares.

Conclusão: Os achados mostram que idade avançada e longo tempo de uso das próteses totais originaram limitado restabelecimento da dimensão vertical de oclusão e amplitude de movimentos mandibulares. Entretanto, o efeito da duração do edentulismo não foi claro.

Palavras-chave: Arcada edêntula; Idoso; Prótese total; Oclusão dentária.

INTRODUCTION

The literature reports a high prevalence of tooth loss among older people (1,2). Dental implants have become the treatment of choice for edentulous patients (3), but conventional complete dentures are still widely used (4).

Previously published research shows that long-term complete-denture wearers often present with loss of vertical dimension of occlusion (VDO) and unstable dentures that are associated with wearing artificial teeth and progressive residual ridge resorption on both the maxilla and mandible (5-7). Studies conducted with these individuals suggest that these aging-associated factors can culminate in the collapse of masticatory muscles, thereby jeopardizing basic functions such as mandibular movements (MM) (8-10). In turn, compromised MM are associated with systemic diseases (11) such as senile dementia, stress-related disorders, and cognitive dysfunctions, which may be due to nutritional deficiencies (12-15).

This study evaluated the effect of age in years, duration of edentulism, and duration of current complete-denture use on the extent of MM and on reestablishment of VDO in complete-denture wearers. The null hypothesis in this study was that there are no relationships between increasing age, duration of edentulism, or duration of current complete-denture use and compromised MM and VDO.

METHODOLOGY

Experimental design

This observational, cross-sectional (for MM), and longitudinal (for changes in VDO) study was approved by the Local Human Research Ethics Committee (protocol no. 63/2013) and conducted in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines (16).

Participants

All elderly complete-denture wearers who came to a social center for seniors between March and November 2014 were invited to participate in the study. Those who met the following inclusion criteria were enrolled: complete-denture wearers (aged 60 to 90 years) who had used the same set of complete dentures for at least five years and needed to have them replaced; had experienced loss of VDO and had loose and unstable dentures due to changes in the orientation of occlusal plane; were free from temporomandibular disorders (TMDs), from limitations affecting opening the mouth, and from pain; and were able to comply with the experimental protocol (i.e., come to the dental clinic to be photographed and to have MM-Gysi arch tracing) (17).

Initially, 131 elderly people were invited to participate; 97 of them did not meet the inclusion criteria and 4 declined to participate because of difficulties traveling to the clinic or work-related duties. After signing a written informed consent form based on the Declaration of Helsinki, the subjects enrolled were evaluated for VDO and extent of MM, at two and one time points respectively, and a questionnaire was administered to collect data on current age, duration of edentulism, and length of time using their most recent set of complete dentures.

The sample size ($n = 8$) needed to compare age, duration of edentulism, and duration of current complete-denture use across tertiles in years was calculated assuming that statistical tests would be used with a study power of 80% ($\alpha = 0.05$) (9). A total of 30 volunteers were enrolled, to account for potential losses during the experiment. The study participants were sequentially assigned to tertiles by years ($n = 10$ per tertile), according to their age, duration of edentulism, and duration of current complete-denture use.

Clinical procedures

After the initial interview, all participants were fitted with new conventionally manufactured complete dentures. Participants' maxillomandibular relationships were evaluated by obtaining their VDO from interocclusal wax records, using the metric, esthetic and phonetic methods. Mandibular and maxillary wax records were adjusted, and the wax was built up or removed to obtain the optimum VDO. The Dawson bimanual technique was used to achieve centric relation (18).

After their new dentures had been fitted, participants were requested to return to the clinic for possible adjustments after 24 hours and 7, 14, and 21 days and then, finally, a week after their last adjustment. All clinical procedures followed the same standardized procedures. All materials were used in accordance with their manufacturers' instructions.

MM and VDO measurements

Frontal photos were taken using a digital single lens reflex camera (Canon EOS Rebel XTi, Tokyo, Japan) mounted on a tripod (19). The camera lens was set up in line with the Frankfort horizontal plane to ensure that each VDO photograph was standardized (20,21). The vertical distance from the base of the nose to the base of the chin was measured twice to determine VDO (Figure 1), once before the new dentures were fitted (T0), and then again seven days after the last appointment for adjusting the new complete dentures (T1). The measurements at T1 were subtracted from those at T0 to calculate the difference in VDO, with a 6-week interval between evaluations.

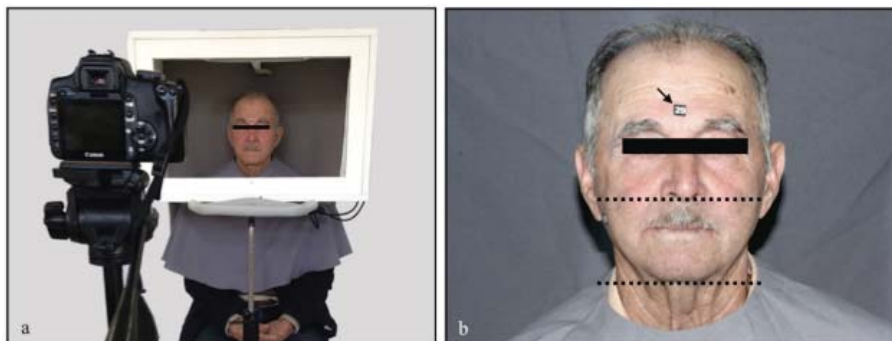


FIGURE 1 – a) Frontal photos were taken with a digital single lens reflex camera mounted on a tripod at a fixed distance from the participants; b) The black arrow indicates a mark (millimeter ruler) to allow accurate measurement and reliable comparisons of VDO in the anonymized photos; and the dotted black lines indicate the two anatomical points (base of nose and base of chin) used to evaluate the vertical distance.

To determine MM, each participant was instructed to perform anteroposterior and laterolateral mandibular movements for 10 minutes on an intraoral record inserted into his or her mouth (22). Digital images provided intraoral Gothic arch tracings and anteroposterior (x-axis) and laterolateral (y-axis) MM measurements (Figure 2). Mandibular movement measurements were conducted once, at T0, while the participants were still wearing their old complete dentures. Afterwards, all subjects were provided with new complete dentures.

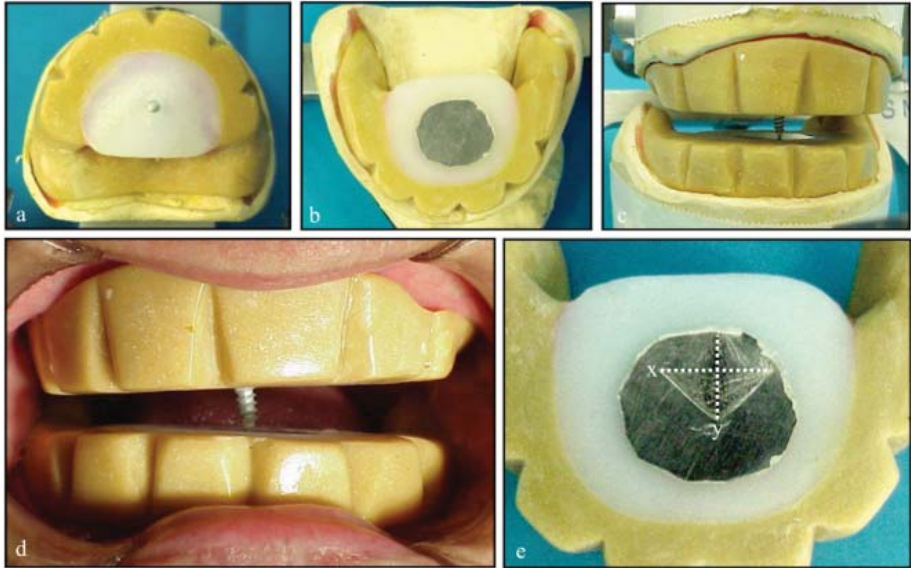


FIGURE 2 – Digital images for Gothic arch tracing. a) Upper; b) Lower intraoral record; c) Position of the upper and lower records; d) Intraoral record inserted into mouth; e) anteroposterior (x-axis) and laterolateral (y-axis) MM measurements.

Each digital image included a millimeter ruler to allow accurate measurement and reliable comparisons of VDO and MM in the anonymized photos (21). The images were imported into image-processing software (Image Tool version 3.0, University of Texas Health Science Center, San Antonio, TX, US) (18) and VDO and MM measurements were taken by one calibrated and blinded examiner.

Statistical analysis

Data were recorded and analyzed using STATA version 13.0 (StataCorp LP, College Station, TX) to a significance level of 5%. Differences in reestablishment of VDO and extent of MM according to age, duration of current complete-denture use, and duration of edentulism were assessed using one-way analysis of variance with a post hoc Bonferroni test to compare outcomes across tertiles in years. Correlations between variables and MM and VDO outcomes were tested using Pearson correlation analysis.

RESULTS

The sample recruited for this study comprised 24 women and 6 men with a mean (standard deviation) age of 70.4 (10.1) years. They had been wearing their current sets of complete dentures for a mean (SD) of 17 (2.2) years and had been edentulous for a mean (SD) of 30.8 (18.5) years.

Pearson correlation analysis detected negative correlations ($P < 0.05$) between duration of current complete-denture use and VDO and MM measurements and between age and VDO and MM measurements (Table 1).

TABLE 1 – Correlations between duration of edentulism, duration of current complete-denture use, and age and mandibular movements (MM) and vertical dimension of occlusion (VDO) measurements.

Parameters evaluated in study participants (N = 30)	MM				Change in VDO ^c	
	x-axis ^a		y-axis ^b		R	P
	R	P	R	P		
Duration of edentulism in years	-0.141	0.268	-0.235	0.171	-0.012	0.646
Duration of current complete-denture use in years	-0.463	0.050*	-0.439	0.048*	-0.425	0.041*
Age in years	-0.506	0.040*	-0.441	0.036*	-0.533	0.032*

Abbreviations: R, Pearson correlation coefficients; T0, before study participants were fitted with new complete dentures; T1, 7 days after the last adjustment of the new complete dentures.

^a x-axis: anteroposterior MM at T0.

^b y-axis: laterolateral MM at T0.

^c Over 28 days, between T0 and T1.

* Statistically significant differences ($P < 0.05$).

Table 2 shows the effects that the parameters investigated had on reestablishment of MM and VDO. Bonferroni testing detected statistically significant differences between the third tertiles for age and duration of complete-denture use (oldest ages and longest periods wearing current dentures, respectively) and the other tertiles ($P < 0.05$) for MM and for changes in VDO, but not for duration of edentulism and MM.

TABLE 2 – Effects of age, duration of edentulism, and duration of current complete-denture use on changes in mandibular movements (MM) and vertical dimension of occlusion (VDO) measurements.

Parameters of study participants (N = 30)	Mean (SD) MM at T0, mm		Mean (SD) change in VDO, mm ^a
	x-axis	y-axis	
Age, tertile in years ^b	$P = 0.050$	$P = 0.047$	$P = 0.018$
1st (60–65)	9.2 (0.15)	9.0 (0.33)	2.00 (0.30)
2nd (66–75)	8.9 (0.21)	8.6 (0.28)	1.55 (0.34)
3rd (76–90)	6.7 (0.23)*	5.9 (0.19)*	0.80 (0.32)*
Duration of edentulism, tertile in years ^c	$P = 0.676$	$P = 0.627$	$P = 0.042$
1st (10–20)	9.5 (0.22)	8.8 (0.30)	1.68 (0.41)
2nd (21–37)	9.0 (0.18)	8.2 (0.25)	1.51 (0.25)
3rd (38–70)	8.9 (0.20)	7.7 (0.29)	0.71 (0.22)*

Parameters of study participants (N = 30)	Mean (SD) MM at T0, mm		Mean (SD) change in VDO, mm ^a
	x-axis	y-axis	
Duration of current complete-denture use, tertile in years ^d	<i>P</i> = 0.050	<i>P</i> = 0.033	<i>P</i> = 0.036
1st (5–6)	9.0 (0.16)	9.1 (0.30)	2.33 (0.18)
2nd (7–12)	8.5 (0.20)	8.1 (0.26)	1.21 (0.10)
3rd (13– 45)	7.0 (0.17)*	6.5 (0.24)*	0.88 (0.21)*

Abbreviations: SD, standard deviation; T0, before study participants were fitted with new complete dentures; T1, 7 days after the last adjustment of the new complete dentures.

^a Change in VDO over 28 days, between T0, before study participants were fitted with new dentures, and T1, 7 days after the last adjustment of the new complete dentures.

^b Mean (SD) age 70.4 (10.1) years.

^c Edentulous for a mean (SD) of 30.8 (18.5) years.

^d Last complete dentures worn for a mean (SD) of 17 (2.2) years.

*Statistically significant differences between the third tertile and the other two tertiles (*P* < 0.05).

DISCUSSION

To the best of the researchers' knowledge, this is the first study to evaluate the effects of increasing age, duration of edentulism, and duration of current complete-denture use on the extent of MM and on reestablishment of VDO in elderly complete-denture wearers.

The null hypothesis tested was partially rejected as both age and duration of current complete-denture use were negatively correlated with optimized MM and VDO. In addition, increase in the length (in years) of any parameter resulted in lower VDO and MM measurements, the only exception being duration of edentulism and MM measurements.

Although the supporting tissue and associated facial structures deteriorate progressively as edentulous patients age (6), these results show that the duration of edentulism was the only parameter that did not have a significant negative correlation with the outcomes evaluated. Likewise, the strong negative correlations between the outcomes investigated and duration of closed-denture use and age indicate that age (8,9) and long-term use of complete dentures compromise MM (9,10,22) and VDO (20).

These research findings corroborate studies that have reported that age affects the function of the stomatognathic system and masticatory muscles (8-15,23). The lower reestablishment of VDO achieved for older patients could be linked to this (20). Study participants aged 76 to 90 years had reduced Gothic arch tracing. This impaired mobility is probably because of reduced VDO and residual ridge resorption over the years,

compromising the translational capacity of the temporomandibular joints, as the effective working length of the masticatory muscles changes (7). Notwithstanding, the higher proportion of older participants with adhesions or disk displacements without reduction might be another explanation and since the prevalence of TMD pain is reduced in elderly populations, anamnestic indices are not helpful for excluding painless TMDs (5). Thus, ageing appeared to have an important effect on the parameters evaluated.

However, these findings also indicate that long-term complete-denture wearers should change their dentures regularly to maintain the health of the stomatognathic system because the duration of closed-denture use has a greater effect on the outcome than does duration of edentulism (8). These results agree with studies showing that optimum prosthodontic treatment for edentulism enables proper masticatory muscle activity (24,25) and could consequently improve MM and VDO patterns. Furthermore, this is an important issue because reduced MM can result in impaired mastication; an epidemiological risk factor for the development of cognitive dysfunction (12-13).

One of this study's strong points is the methods used to measure MM and VDO, using standardized VDO frontal photographs and Gothic arch tracing records. Additionally, using Image Tool software and including the millimeter ruler in each photographic record ensured that measurements were accurate and reliable (21).

Our findings should be interpreted with caution because to our knowledge this is the first study that has evaluated both MM and VDO under the influence of all outcomes investigated. One of the limitations of this study was the short-term VDO measurement, since long-term effects are more relevant clinically. Mandibular movements were only assessed once because the aim was to determine the magnitude of MM before any clinical and prosthodontic treatment, to avoid influence on MM measurements from the new prostheses. Further research should be conducted to evaluate the functional parameters of edentulous patients since the factors that predispose people to oral and/or systemic diseases—and their frequency and severity—can change over time.

CONCLUSION

The study findings show that older age and long-term use of dentures were linked with limited reestablishment of vertical dimension of occlusion and range of mandibular motion. However, the effect of duration of edentulism was not clear.

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