Journal of Dentistry Indonesia

Volume 29 | Number 2 Article 8

8-31-2022

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Recommended Citation

Rajali, A., Mustafa, N., Zulkiflee, M., Abd Rahman, A., & Ahmad, R. The Impact of The Labial Flange and Artificial Teeth on Lip Support in Elderly Patients with Maxillary Complete Dentures. J Dent Indones. 2022;29(2): 127-133

The Impact of The Labial Flange and Artificial Teeth on Lip Support in Elderly Patients with Maxillary Complete Dentures

Cover Page Footnote

ACKNOWLEDGMENT We thank the participants and staff of Universiti Teknologi MARA for their support of this study.

Journal of Dentistry Indonesia 2022, Vol. 29, No. 2, 127-133
doi: 10.14693/jdi.v29i2.1334

ORIGINAL ARTICLE

The Impact of The Labial Flange and Artificial Teeth on Lip Support in Elderly Patients with Maxillary Complete Dentures

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ABSTRACT

Both maxillary complete denture's labial flange and anterior artificial teeth play important roles in re-establish major support for the upper lip of elderly patients. However, whether the labial flange can be removed and still perceived as aesthetic remain unclear. **Objective:** To determine the perception of young adults toward the effect of a labial flange and anterior teeth on lip support of an elderly with maxillary complete dentures. **Methods:** A total of 64 young adults were recruited to evaluate the lip support for facial aesthetics of 30 full-face photographs in 3 different states: with an original complete denture (CD), with a flangeless duplicated denture and without the complete denture. They were rated using a Visual Numerical Scale (VNS) of 10, with 1 being the least attractive and 10 being the most attractive and repeated twice in random order. Soft-tissue profile analysis was performed to determine which facial anatomical landmarks were most important for lip support and aesthetics. **Results:** The overall VNS rating with CD (6.33 ± 0.58) was significantly higher ($p < 0.001$) than images with flangeless (5.58 ± 1.01) or without CD (5.23 ± 1.30). The landmarks that showed the most significant changes were in the subnasale area and NLA with original CD ($p=0.060$, $p=0.072$) and in frontal lip thickness with flangeless ($p=0.082$). There are strong correlations between subnasale and NLA and the mean total aesthetic VNS rating of images with CD, but not statistically significant ($r=0.708$; $p=0.118$, $r=-0.835$; $p=0.078$). **Conclusion:** The labial flange of a maxillary complete denture plays an important role in lip support and results in the aesthetic perception of the dentures wearer. The anterior teeth alone provide fullness to the lips, but not enough for labial support.

Key words: aesthetics, complete denture, elderly, labial flange, lip support

How to cite this article: Rajali A, Mustafa NWNA, Zulkiflee MZA, Abd Rahman AN, Ahmad R. The impact of the labial flange and artificial teeth on lip support in elderly patients with maxillary complete dentures. J Dent Indones. 2022;29(2): 127-133

INTRODUCTION

Residual ridge resorption results in an aging appearance as the face collapses due to lack of support and unopposed contraction of facial muscles.[1-3] The amount of alveolar ridge resorption, lip thickness, nose length, angulation of the nasal tip and nasolabial angle, labial flange, and maxillary anterior tooth positions are all factors that affect labial supports.[4,5] Lip support is important for aesthetics in complete denture patients with moderate to advanced resorption, as it is mostly replaced by the labial flange and the denture's artificial anterior teeth,[6-8] but such evidence-based guideline is lacking.[3-8] The thickness of the labial flange is usually calculated based on how much ridge resorption must be compensated for in order to recreate the pre-extraction facial appearance.[3,4] However, Bidra et al.,[5] found that adding a labial flange to an elderly white patient's labial support makes no difference in terms of clinical outcomes. They found no link between differences in labial flange thickness measurements and patient-related factors like gender or prior years of edentulism.

As a result, when the prosthetic teeth positions are appropriate, the authors proposed that lip support by the labial flange is not necessary.[4,5]

Several previous studies on the effects of age, gender, and ethnicity on lip support yielded inconclusive results. Kamashita et al.[3] investigated the lip support of Japanese elderly edentulous patients using experimental record blocks to simulate complete dentures. They concluded that the presence of anterior artificial teeth has an effect on lip supports, whereas the labial flange has an effect on nose counter, nasolabial angle, and lip positional relationship. This contradicts the findings of Bidra et al.[5], who discovered no association between gender and years of edentulism with the nasolabial angle and subnasale area in their elderly white patients, but agrees with Hernandez et al.,[9] who discovered significant changes in oral tissue and the need for labial support when constructing complete dentures among the elderly white, particularly men.

Soft-tissue profile analysis has been shown to be effective in determining the amount of lip support required for a denture patient.[5] The position of the lips and the nasolabial angle have been studied[4,5,8] and found to have the greatest impact on facial profile.[10-13] In dentate individuals with a normal profile, the nasolabial angle ranges from 90 to 95 degrees for men and 100 to 105 degrees for women. When complete dentures were inserted, Bidra et al., found significant differences in the nasolabial angle and subnasal area, but the differences were too small to be clinically significant.[5] In contrast, You et al., discovered that a visual sensitivity threshold of more than 5.36 degree in soft tissue profile aesthetic evaluation was clinically significant, indicating that human eyes can detect small differences in the nasolabial angle.[14]

Aesthetic perception differs from one person to the next and is influenced by personal experience, age, gender, ethnic group, and the social environment. The dentists' opinions on facial aesthetics also differ from patients' perceptions.[15-17] Therefore, the objective of this study was to evaluate the impact of eliminating labial flanges from complete denture on the facial aesthetics of Malaysians. The null hypothesis is that there is no significant difference in aesthetic perception between the conventional complete denture and the flangeless denture.

METHODS

Participant recruitment

Five elderly patients were recruited for this study from the Dental Clinic of Universiti Teknologi MARA in Malaysia, based on the following inclusion criteria: Malay ethnicity, age 60 and above, good general and oral tissue health, and edentulous for at least a year. If they had facial or lip anomalies, implant surgery in the maxillary arch, a history of maxillofacial trauma, a moustache, or were unwilling to be photographed, they were excluded. The Research and Ethics Committee, Universiti Teknologi MARA 600-IRMI (5/1/6), granted ethical approval for this study, and it was carried out in accordance with the Declaration of Helsinki.

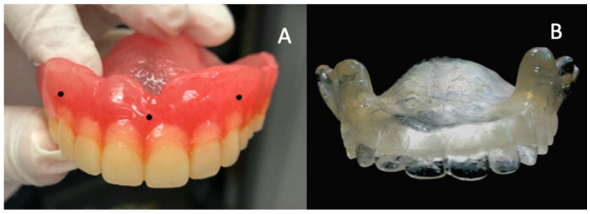

Figure 1. Thickness measurement. A) Original patient's existing maxillary denture with three point for thickness measurement. B) Flangeless duplicated denture created by labial flange removal.

Figure 2. Photograph images of a patient; A) With complete dentures in the mouth; B) With flangeless duplicated denture; C) Without complete denture.

Measurement of the thickness of labial flange

Each participant's complete maxillary denture's labial flange was measured by two examiners at three points with a calliper: the central teeth area (Point A) and both canine areas (Point B and Point C) (Figure 1A). The denture was then duplicated in clear acrylic resin and the labial flange removed (Figure 1B).

Profile and frontal photography

A DSLR camera (Nikon D3100, Japan) was used to photograph the participants' faces in profile and frontal orientations. The camera was mounted on a tripod and placed at a controlled distance of 1.5 metres from the seated patient. The camera was calibrated for each individual and set horizontally at eye level.[4] The camera was set to a focal length of 55mm, an ISO of 200, and a shutter speed of 1/60. The photographs of each patient were taken with a natural head position, lips and teeth

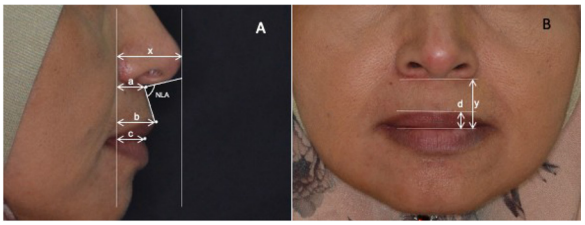

Figure 3. A) Photograph images showing methodology of measurements of various facial anatomic landmarks; Subnasale (a/x), labrale superior (b/x), and stomion (c/x) were measured as ratios, and B) Nasolabial angle was measured in degrees and frontal lip thickness (d/y).

in a rest position, with the existing complete maxillary denture in the oral cavity. Then, in the same controlled manner, profile and frontal digital photographs of patients with and without the flangeless duplicated denture were taken. For photographic analysis, six digital images per patient were collected and saved in JPEG format (Figure 2). Before being incorporated into a digital slide presentation programme, all full-face profile and frontal photographs are cropped to a standard size and evaluated for consistency in head position and image quality using a digital photography manipulating software programme (Adobe Photoshop CS6; Adobe Systems, San Jose, CA) (Microsoft PowerPoint 2016; Microsoft, Redmond, WA). To present to the judges, a total of 30 photographs are used.

Facial aesthetics rating based on Visual Numerical Scale (VNS)

A total of 64 judges were chosen based on their self-identified backgrounds and ages ranging from 19 to 24 years old for both female and male judges. The judges are all Malay Malaysians. There were 36 dental students and 28 laypeople among the judges. The total judges were more than enough to demonstrate the mean differences, according to the power calculation using G*Power version 3.1.9.4 with α set to 0.05 and power set to 85% with consideration of 5% dropout. The judges were then briefed on the selective components of the study and the nature of their participation after providing verbal and written consent. All judges were blinded to the fact that the study was about changes in lip support due to flangeless dentures, and they had to rate the facial aesthetics of 30 digital images on a scale of 10 on the Visual Numerical Scale (VNS). There were two sets of 30 photo evaluations, each in a different order. Each photograph had to be judged twice, in random order, by the judges. The judges were also required to drop out of the study if they knew or recognised any of the patients photographed.

The VNS scale was 0-10 and was arranged according to the order of images, with "least aesthetic" on the left and "most aesthetic" on the right. A digital slide presentation with 60 digital photographs in randomised sequence was projected on a screen, with each slide containing only one photograph, and judges were asked: "How do you rate the facial aesthetics of this image on a scale of 0 to 10?" After that, each judge assigned a score based on their assessment of facial aesthetics. Each slide has a time limit of 5 seconds. The second round was conducted with images in a random order to assess intra-examiner consistency.

Measurement of Facial Anatomical Landmarks

For each profile photograph, Adobe Photoshop CS6 was used to measure the facial anatomical landmarks at a magnification of 200 percent (Figure 3). The horizontal nasolabial boundary was established by drawing two vertical lines at the alar border of the nose and the anterior-most point of the nose (pronasale). Between these two lines, the constant variable "x" was measured. Then, at the subnasale (a), labrale superior (b), and stomion (c), three vertical lines were drawn (c). The three ratios, as shown in Figure 3A, represented the projection of the maxillary lip at three points. The distance between ala nasi and subnasale (a/x) was divided by the distance between ala nasi and pronasale. The distance between the ala nasi and the labrale superior was divided by the distance between the ala nasi and the pronasale (b/x). The distance between the ala nasi and the stomion was divided by the distance between the ala nasi and the pronasale (c/x). The ratio of the vertical line between the two superior-most points of the philtrum (d) and the vertical line between the subnasale and the stomion (y) was used to calculate the lip thickness (Figure 3B).[5,18] At the intersection of lines across the lower end of the linear part of the columella and soft tissue subnasale, and another line across labrale superior and soft tissue subnasale, differences in the nasolabial angle (NLA) were measured. All measurements were done in triplicate to ensure accuracy.

Statistical analysis

The Statistical Package for the Social Sciences (SPSS) was used to conduct all data analyses (SPSS, IBM Corp, Version 24.0. Armonk, NY). An average of the VNS ratings was calculated among the subjects before the mean and standard deviation were calculated. To compare differences between the original complete denture, flangeless denture, and no denture, a one-way ANOVA was used with a Turkey post hoc test. To determine the thickness and mean of the profile's anatomic landmarks ratio, a paired t-test was used. Pearson correlation was used to examine the relationship between variables. The level of statistical significance was set at $p < 0.05$.

RESULTS

Participants demographic data

Five Malay patients were enlisted: three (3) females and two (2) males. The average age was 63.6 ± 5.2 years. Patients had been edentulous for an average of 5 ± 3.3 years.

Table 1. The VNS ratings for facial esthetics of images' with complete denture, flangeless duplicated dentures and without complete denture

Variable	Mean Rating (SD)			Mean difference (SD)					
	With CD	Flangeless	Without CD	With CD and Flangeless	p	Flangeless and Without CD	p	With CD and Without CD	p
Overall	6.33 ± 0.58	5.58 ± 1.05	5.28 ± 1.30	0.75 ± 0.70	0.000*	0.31 ± 0.68	0.003*	1.05 ± 0.72	0.000*
Frontal Images	6.31 ± 1.05	5.84 ± 0.90	5.52 ± 1.22	1.10 ± 0.83	0.000*	0.21 ± 1.03	0.110	1.31 ± 1.36	0.000*
Profile images	6.34 ± 1.11	5.24 ± 1.11	5.03 ± 1.39	0.47 ± 0.83	0.000*	0.32 ± 0.72	0.001*	0.78 ± 1.23	0.000*

Total Judges N=64. *indicates significance at p<0.05

Table 2. The VNS ratings for facial aesthetics based on judge status and gender

Type of images	Variable	Judges' Category			Gender		
		Mean rating ± SD		p	Mean rating ± SD		p
		Dental Students (N=36)	Laypeople (N=28)		Male (N=32)	Female (N=32)	
Frontal images	With CD	6.34 ± 0.98	6.26 ± 1.15	0.754	6.42 ± 1.02	6.19 ± 1.08	0.388
	Flangeless	5.90 ± 0.86	5.77 ± 0.97	0.565	5.85 ± 0.91	5.83 ± 0.91	0.924
	Without CD	5.56 ± 1.22	5.47 ± 1.24	0.767	5.57 ± 1.28	5.48 ± 1.18	0.770
Profile images	With CD	6.52 ± 1.13	6.11 ± 1.06	0.147	6.36 ± 1.02	6.33 ± 1.22	0.929
	Flangeless	5.43 ± 1.14	5.00 ± 1.04	0.127	5.18 ± 1.05	5.30 ± 1.18	0.672
	Without CD	4.94 ± 1.45	5.15 ± 1.32	0.567	4.98 ± 1.51	5.09 ± 1.27	0.741

Total Judges N=64. *indicates significance at p<0.05.

Table 3. Differences between profile measurement with complete denture, flangeless dentures and without complete denture for five(5) predefined facial anatomic markers

Variable	Mean (SD)			Mean difference (SD)					
	With CD	Flangeless	Without CD	With CD and Flangeless	p	Flangeless and Without CD	p	With CD and Without CD	p
Subnasale (a/x)	0.443 ± 0.037	0.378 ± 0.081	0.371 ± 0.041	0.066 ± 0.057	0.060	0.007 ± 0.060	0.827	0.072 ± 0.045	0.023*
Labrale superior (b/x)	0.573 ± 0.095	0.550 ± 0.097	0.456 ± 0.065	0.023 ± 0.097	0.618	0.094 ± 0.117	0.149	0.117 ± 0.117	0.131
Stomion (c/x)	0.436 ± 0.002	0.412 ± 0.103	0.319 ± 0.059	0.024 ± 0.101	0.630	0.093 ± 0.044	0.110	0.117 ± 0.057	0.100
Nasolabial angle (in degree)	96.87 ± 14.85	101.55 ± 12.22	104.1 ± 10.62	4.68 ± 4.97	0.072	2.55 ± 4.36	0.111	7.23 ± 8.93	0.042*
Frontal lip thickness (d/y)	0.321 ± 0.045	0.316 ± 0.046	0.275 ± 0.068	0.005 ± 0.049	0.838	0.041 ± 0.057	0.082	0.046 ± 0.057	0.063

*indicates significance at p<0.05

Table 4. Correlation of the mean total VNS rating of images with complete denture in relation to anatomical landmarks

Variable		Mean Total VNS Rating
Subnasale (a/x)	Pearson Correlation	0.708
	Sig (2-tailed)	0.181
Labrale superior (b/x)	Pearson Correlation	0.656
	Sig (2-tailed)	0.230
Stomion (c/x)	Pearson Correlation	0.530
	Sig (2-tailed)	0.359
Nasolabial angle (in degree)	Pearson Correlation	-0.835
	Sig (2-tailed)	0.078
Frontal lip thickness (d/y)	Pearson Correlation	0.124
	Sig (2-tailed)	0.843

Total images N=5.Total judges=64. *indicates significance at $p<0.05$

Thickness of labial flange

The mean denture flange thickness was 4.97 ± 1.07 mm. Point A (central), Point B (canine), and Point C (canine) had thickness measurements of 5.22 ± 1.255 mm, 4.90 ± 1.465 mm and 4.80± 1.145 mm respectively. The Cohen kappa coefficient was used to assess the consistency of the measurements between the first and second examiners for each point, and it was found to be repeatable (Point A=0.997, Point B=0.998, Point C=0.997).

Facial aesthetics rating based on Visual Numerical Scale (VNS)

The 64 judges recruited had an average age of 21.6 ± 1.5 years. The mean ratings across all judges for facial aesthetics of flangeless duplicated dentures were slightly lower than those of conventional complete dentures, as shown in Table 1. Result shown that for both frontal and profile images, the overall VNS ratings for facial aesthetics between images with CD, flangeless and without CD were statistically significant (p=0.001). Profile images with CD received the highest rating for facial aesthetics (6.33 ± 0.58) when compared to images with flangeless duplicated denture (5.58 ± 1.05) and without CD. For profile images, however, VNS ratings were not significantly different (P=0.110) between the flangeless and with CD. When VNS ratings were analyzed based on the status of the judges, laypeople consistently provided the lowest ratings, followed by dental students, but the differences were not significant (Table 2). The differences in VNS ratings based on judge gender were minor and not statistically significant ($p>0.05$).

Anatomical landmarks

Table 3 depicts the predefined facial anatomic markers that differentiate the with CD, flangeless, and without CD. The most noticeable differences were found at the subnasale and NLA when comparing with CD and flangeless denture (p=0.060, p=0.072). When comparing with and without CD, the area subnasale and NLA showed the most significant results, with P-values of 0.023 and 0.042, respectively. When comparing between flangeless and without CD, the frontal lip thickness showed the largest difference, though it was not statistically significant (p=0.082). Table 4 depicts the relationship between these landmarks and the aesthetic VNS ratings of images with CD; the subnasale exhibits high positive collinearity, while the NLA exhibits high negative collinearity.

DISCUSSION

The current study sought to ascertain the impact of the labial flange on lip support and, as a result, aesthetic perception. The overall findings of this study indicated that there were significant differences in perception when evaluating conventional complete denture and flangeless denture, so the null hypothesis was rejected. In this study, the full flange extension is aesthetically more acceptable and the VNS rating of facial aesthetics images with the complete denture was higher than flangeless duplicated denture.

To eliminate bias, all judges were completely blinded to the objectives when evaluating the difference in lip support between with the flange and flangeless dentures. Despite the blinding effect, all judges rated the facial aesthetics of flangeless dentures slightly lower than complete dentures. The judges who participated were dental students and young laypeople, with 56.3 percent and 43.7 percent, respectively. Despite their disparities in background, no significant findings were discovered during the evaluation. Previous work has found that professionals outperform laypeople in terms of aesthetics.[16,19] However, there are multifactorial explanations for this result, such as experiences and significant landmark variations.[10,14] The outcome demonstrates that, in the eyes of both evaluators, the lip contour supported by the flange met aesthetic

criteria. A similar finding had been made between genders. Although Wen et al[10] and Nomura et al[19] came to different conclusions, they both agreed that the judge's and patient's race and ethnicity, as well as gender, may play a role in the individual's perception of his or her lip profile.

Meanwhile, the average thickness of the labial flange in this study was 4.97 ± 1.07mm, which is higher than the recommended thickness of 2 to 3 mm.[3, 21,22] Thus, no ideal thickness should be emphasized because the flange thickness is proportionately dependent on the underlying maxillary bone which undergoes continuous resorption and varies between individuals.[4,5] However, when the labial flange was removed, the subnasale area changed, indicating that the thickness border of the labial flange has an impact on the lip supports. The subnasale which is located at the intersection of the lower border of the nose and the upper lip influences facial aesthetics, as evidenced by the detectability of changes in subnasal with high collinearity correlation.[9,13,14] Subnasale lengthens the philtrum and the upper lip vermillion.[3,7,23] It is considered ideal if the upper lip vermilion is 2-3mm less than the lower lip vermilion.[23] The presence of anterior teeth influenced lip support in this study, as evidenced by the difference in lip fullness provided by the flangeless versus that without CD. Therefore, the labial flange should not be removed and should only be slightly reduced to avoid facial changes.[3,7, 23-25]

The nasolabial angle (NLA) is influenced by maxillary protrusion and the thickness of the soft tissue overlying the lips and is important in determining the anteroposterior relationship of the maxilla to the profile.[2,13,23] On dentate patients, the nasolabial angle and lip position relationships to the face have been investigated using a profile view, cephalometric analysis, and a silhouette profile.[9,10,23] In this study, the NLA of the with CD was found to be more acceptable, with a mean value of 96.87 ± 14.85 degrees, compared to the flangeless and without CD, which had much higher values (Table 3). In young adult groups, Talib et al[11] and Lin et al[12] discovered that both Malay males and females had acute nasolabial angles. Furthermore, fully dentate Malaysian Malays are said to have protruding and thick upper lips.[10-12] According to Azad et al.,[26] edentulous Pakistani elderly aged 50 and above had an NLA of 111.40 ± 2.51, which was higher than the 104.1 ± 10.62 of the edentulous Malaysian elderly in this study. With NLA differences of more than 4.68 and 7.23 degrees, almost all of the judges were able to detect the difference in profile images of the CD, flangeless, and without CD. As a result, an acute NLA has a significant impact on facial aesthetics, with judges preferring the with CD. The labial flange reduced the nasolabial angle by providing lip support and serves as a useful parameter in complete denture aesthetic planning.[3,21,24]

The overall findings of this study imply that for adequate lip support and face aesthetics, a labial flange that extends to the full thickness and width of the buccal sulcus is required. The findings, however, should be regarded as preliminary because they are based on a small number of patients and a narrow range of judges. For more conclusive findings, more research with a larger participant sample size and a diverse panel of judges is required.

CONCLUSION

Within the limitation of this study, the labial flange of a maxillary complete denture has been shown to play a significant role in lip support and consequent aesthetic perception by young adults towards the elderly patient with the maxillary complete dentures. The overall VNS rating of facial images with CD (6.33 ± 0.58) was significantly higher ($p < 0.001$) when compared to the images with the flangeless (5.58 ± 1.01) and without CD (5.23 ± 1.30). The anterior teeth alone provide fullness to the lips, but not enough for labial support.

ACKNOWLEGEMENT

We thank the participants and staffs of Universiti Teknologi MARA for their support towards this study.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

PATIENT DECLARATION OF CONSENT

The authors certify that they have obtained all appropriate patient consent forms. In the form the patients have given his/her consent for his/her other clinical information to be reported in the journal. The patients understand that their names and initials will not be published to conceal their identity.

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(Received December 30, 2021; Accepted August 2, 2022)