

Original paper

The influence of retention of upper and lower complete dentures on masticatory efficiency

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Summary

In this investigation the denture retention was measured and the influence of denture retention on masticatory efficiency was examined. The investigation was performed on 36 complete denture wearers.

The test of masticatory efficiency was used according to Nikšić (1965).

The measuring of denture retention was made by specially constructed mechanical scale, which was designed so that the load on the scale could be converted into the pulling force which acted against forces of retention.

The correlation between specific denture retention and masticatory efficiency showed no correlation for the variables of the lower denture, and slight, but not significant correlation for the variables of the upper denture.

INTRODUCTION

The difference between the configuration of the anatomical base of the upper and lower dentures suggests that the retention of the lower complete denture represents a greater problem for prosthodontists than the retention of the upper complete denture. Since masticatory efficiency represents the quantitative indicator for the functional value of the denture, the following investigation was made to find out if there is any connection between the magnitude of the retention of the upper and lower complete dentures and masticatory efficiency test.

MATERIALS AND METHODS

The investigation was made on 36 patients from the Department of Removable Prosthodontics of the Faculty of Dentistry of Zagreb. There were 13 males and 23 females, ranging between 33 and 80 years of age (Table I).

SUBJECTS	N	AGE RANGE
MALES	13	51-77
FEMALES	23	33-80
TOTAL	36	33-80

Table I — Total of thirty-six patients, divided according to sex, ranging between 33 and 80 years of age.

Tablica I — Podjela pacijenata prema spolu, u rasponu dobi od 33 do 80 godina.

All patients were in good physical health, mobile and cooperative. There were no complaints of complications with dentures, and the clinical examination of the oral cavity showed good tissue condition. Occlusion and articulation of dentures were also checked to assure the absence of irregular cusp contacts which would influence the stability of dentures during mastication.

Nikšić's test of masticatory efficiency,¹ made up the first phase of the investigation. The test material consisted of 100 roasted barley grains which were chewed to the rhythm of a timer. The frequency was 1 chewing cycle per second. The test consisted of two parts — the first was preparatory when the patient practiced the chewing rhythm, and the second, experimental, when he made 20 chewing cycles to the rhythm of the timer. The test was repeated three times consecutively, and between each series of 20 chewing cycles the patient rested for 5 minutes — to avoid fatigue of the masticatory muscles.

After each series of 20 chewing cycles the tested material was collected. The patient spit out the chewed material into the prepared container, and washed out any remains of grains from the mouth. The content of the container was sifted, rinsed under running water, and placed on a sheet of blotting paper to separate whole grains from larger unsieved particles.

The remaining unchewed grains were counted and subtracted from 100, to calculate the number of chewed grains. These were data for the statistical analysis.

The arithmetical mean for the chewed grains was counted from the following formula:

$$\bar{X} = 100 - \frac{(a + b + c)}{3}$$

a, b and c represent the number of unchewed grains from the first, second and third tests. \bar{X} represents the arithmetical mean for the number of chewed grains.

The second phase of this investigation was measurement of the individual retention force for the upper and lower complete dentures.

An apparatus with mechanically scaled arms and connective parts for the dentures was used for this purpose (Fig. 1). The scaled arms were designed so that the load on the scale could be converted into the pulling force, which tended to displace the denture from its basal seat, i.e., which acted against forces of retention. The pulling force was caudally applied on the upper denture and cranially on the lower denture. In both cases the direction of the displacing force perpendicular to the occlusal plane of the denture.

Since investigation of denture retention was made with dentures in the mouth, care was taken to not disturb their normal position. Therefore a strong wire hook was fixed on the polished surface of the palatal side of the upper complete denture in the middle of the line joining the interdental spaces between canines and first premolars (Fig. 2). The hook was inserted into the metal ring on the arm of the scale, so that during loading, the pulling force was caudal on the upper denture. The moment the pulling force was stronger than denture retention, the denture was displaced from its base. This was the value of retention for the upper complete denture.

It was not possible to apply the pulling force in only one point of the lower complete denture, because this would destabilize the denture. Attention was also paid to retaining the harmonious relationship between the muscles and the denture by not opening the mouth too wide. For these reasons the lower denture was connected with the wire arch at two points — left and right interdental space between canine and premolar (see Fig. 2). The arch was connected at the level of the bridge of the nose with the arm scale, so that the patient could keep his mouth half-open. The pulling force was applied cranially to the lower denture and when the pulling force was stronger than denture retention, the wire arch lifted the lower denture from its base. This value was taken as the value of the retention for the lower complete denture.

Measurements were performed while the patient was seated in a dental chair in an upright position, with his head fixed in a specially designed head-holder, which prevented antero-posterior and lateral movements of the head (Fig. 3). Retention of the upper denture could be measured with the head fixed in this way, but it was also necessary to secure the mandible in a half-opened position

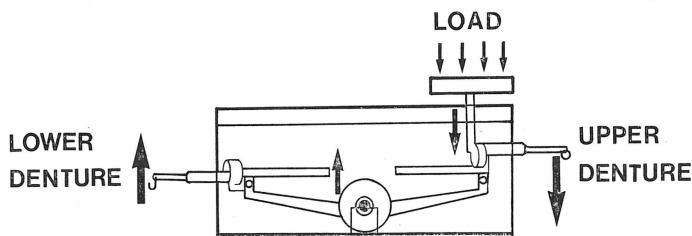


Figure 1. Mechanism for measuring retention of the dentures. Loading of scale causes movement of their arms in opposite directions, and displacement of the denture from its basal seat.

Slika 1. Aparatura za mjerenje retencije proteza. Opterećenje vage izaziva pomicanje njenih krakova u suprotnim mjerovima, a također i odizanje proteze sa njenog ležaja.

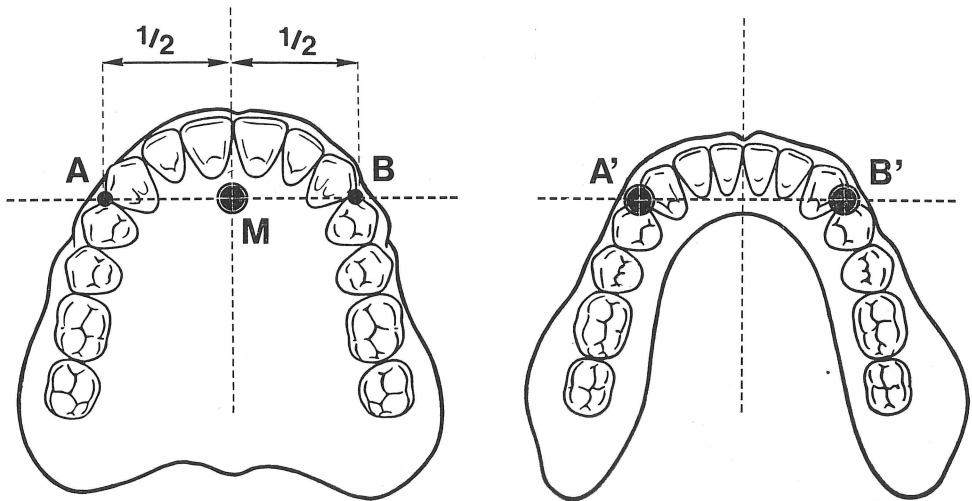


Figure 2. Positioning of connective elements on the polished surface of the upper and lower complete dentures. For the upper complete denture, the wire hook was attached in the middle (M) of the joining line between canine and first premolar left (A) and right (B). For the lower complete denture the wire arch was attached to the denture at two points — the left (A') and right (B') interdental space between canine and first premolar. Slika 2. Pozicioniranje elemenata kojima se proteza povezuje sa krakovima vage. Kod gornje totalne proteze to je žičana kvačica smještena na sredinu (M) linije koja spaja interdentalne prostore kanina i prvog premolara na lijevoj (A) i desnoj (B) strani. Na donju totalnu protezu pričvrsti se žičani luk u dvije točke — lijevi (A') i desni (B') interdentalni prostor između kanina i prvog premolara.

while retention of the lower denture was measured. This was obtained by specially designed mandibular bow, whose length and inclination, in relation to the upper part of the head-holder, could be adjusted. The support with the mandibular bow was obtained by means of an acrylic concave plate, which was positioned on the most prominent part of the chain.

To get a specific retention force, it was necessary to measure the area of the denture base. An impression of the denture base was made with softly mixed elastomer to obtain a very thin film of material. This was then traced on scaled paper and the area was measured in square centimeters.

The measured value of denture retention, which was obtained in newtons (N), was divided by the area in cm^2 . The specific retention force was computed in N/cm^2 for the upper and lower dentures for each patient.

RESULTS AND DISCUSSION

Mean values of the measured characteristics for the upper and lower complete dentures are shown in Table II.

The mean value for the measured retention of the upper complete denture was 68.85 N, and for the complete lower denture 8.53 N, or 12.38% of the value for the upper complete denture.

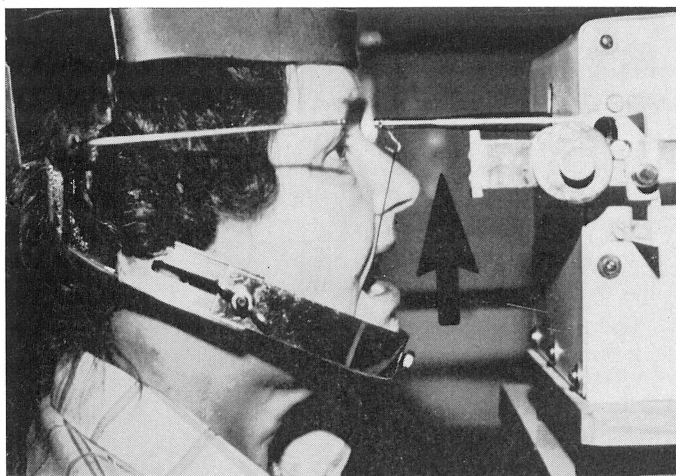


Figure 3. Measurement of retention of lower denture. Patient's head is fixed in the head-holder, and the mandible is supported with the mandibular-bow, in a half-opened position. The pulling force tends to displace the lower denture cranially.

Slika 3. Prikaz mjerenja retencije donje proteze. Glava pacijenta učvršćena je pomoću držača za glavu, a mandibula je postavljena u polu-otvoreni položaj pomoću mandibularnog luka. Sile vlakla nastoje protezu pomaknuti u kranijalnom smjeru.

MEASURED CHARACTERISTICS	UPPER DENTURE (\bar{X})	LOWER DENTURE (\bar{X})	LD/UD %
RETENTION (N)	68.85	8.53	12.38
AREA (cm ²)	34.64	23.60	68.13
SPEC.RETENTION (N/cm ²)	2.01	0.35	17.41
TME	$\bar{X} = 61.95$		

Table II — Mean values of measured characteristics for the upper and lower dentures. The last column presents the values in percentages.

EMG — Mean value chewed barley grains in masticatory efficiency test.

Tablica II — Srednje vrijednosti karakterističnih mjerenja za gornju i donju protezu. Posljednja kolona daje vrijednosti u postocima.

EMG — srednja vrijednost sažvakanih zrna ječma u testu masticatorne efikasnosti.

The mean value of the base area of the upper complete denture was 34.64 cm², and of the lower complete denture, 23.60 cm², or 68.13% of the value of the upper complete denture.

The variable for specific retention (i.e. the value of retention per unit of area) was obtained on the basis of the measured values for the retention and the area of the denture base. The mean value of specific retention for the upper complete denture was 2.01 N/cm² and for the lower complete denture 0.35 N/cm², or 17.41% of the value of specific retention of the upper denture.

The mean value of the masticatory efficiency test was 61.95%, which indicated good functional ability of the complete dentures.

Table II indicates a significant difference between the total and specific retention of the upper and lower dentures. A correlation was made for the variables of retention and the area of the denture base for the upper and lower dentures (Table III). The correlation coefficient for the variables of the upper complete dentures was $r = 0.18$, and for the lower complete dentures, $r = 0.49$. The greater significance of the correlation coefficient for the examined variables of the lower complete denture suggests that the denture base plays a greater role in the retention of the lower denture as compared with the upper denture. The importance of the extension of the complete lower denture has been reported by Barret and Haines², Preiskel³ and Hartwell⁴, particularly with regard to the retention and stabilization of the denture.

The retention of dentures, when they are in a static position, has been investigated by many authors. They have discussed the importance of various factors such as adhesion, cohesion and surface tension Craig and Beny⁵, viscosity of the layer of fluid between the denture and mucosa Östland⁶, reduced atmospheric pressure Stamoulis⁷, capillary attraction Blahova i Neuman⁸, muscle activity Brilland Tryde⁹ and the material of which the dentures are made.¹⁰ The subject of this investigation was not to examine the individual contribution of these factors, but to investigate the specific force of retention of both the upper and lower complete dentures.

The specific retention of dentures, measured when they were seated in the mouth, was correlated with the masticatory efficiency (TME). The correlation coefficient (Table IV) between the variables of the upper denture was $r = 0.07$.

VARIABLES	r
RETENTION U.D. — AREA U.D.	0.18
RETENTION L.D. — AREA L.D.	0.49

Table III — Correlation coefficients between retention and denture base area, for the complete upper and lower denture.

Tablica III — Koeficienti korelacije između retencije i veličine baze proteze, za totalnu gornju i donju protezu.

VARIABLES	r
TME – SPEC.RET. U.D.	0.14
TME – SPEC.RET. L.D.	0.07

Table IV — Correlation coefficients between masticatory efficiency test and specific retention of complete upper and lower denture.

Tablica IV — Koeficijenti korelacije između testa mastikatorne efikasnosti i specifične retencije totalne gornje i donje proteze

These results, which showed no correlation for the variables of the lower denture, and a slight, but not significant correlation for the variables of the upper denture, indicate that besides the retention of dentures, other factors influence the masticatory efficiency, such as muscular activity (Nikšić, Valentić),¹¹ chewing force,¹² neuromuscular control of mastication Thexton¹³, Valentić¹⁴, and other causes effective when the dentures are functioning.

The correlation between the age of patients and denture retention for males and females was also calculated (Table V). Table V indicates that correlation has a negative direction, which means that the increase of one variable — the age of the patients — is followed by the relative decrease of another variable — denture retention, in this case.

The correlation coefficient was slightly more significant for females than for males, and greater values were obtained for lower denture variables.

VARIABLES	MALES (r)	FEMALES (r)
AGE – RETENTION U.D.	-0.14	-0.24
AGE – RETENTION L.D.	-0.17	-0.42

Table V — Correlation coefficients between age of patients and retention of the complete upper and lower denture according to sex.

Tablica V — Koeficijenti korelacije između starosti pacijenta i retencije totalne gornje i donje proteze, po spolu.

CONCLUSIONS

The functional ability of complete dentures can be evaluated with the chosen masticatory efficiency test, and in this investigation it was 61.95% for the edentulous subjects wearing complete dentures.

There was a positive correlation between denture retention and the denture base area, which was more significant for lower denture variables.

The specific retention of the upper denture showed a positive but slight correlation with the masticatory efficiency test, whereas the specific retention of the lower denture showed no correlation with the test.

The correlation between the age of patients and denture retention was negative and slightly more significant for females.

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Sažetak

UTJECAJ RETENCIJE GORNJE I DONJE TOTALNE PROTEZE
NA MASTIKATORNU EFIKASNOST

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Ključne riječi: totalne proteze, retencija, mastikatorna efikasnost

Razlike u konfiguraciji anatomske baze gornje i donje totalne proteze govore u prilog činjenici da retencija donje totalne proteze predstavlja veći problem za protetičare nego retencija gornje totalne proteze. Budući da mastikatorna efikasnost predstavlja kvantitativni pokazatelj funkcijske sposobnosti proteze, u ovom istraživanju željelo se ispitati da li postoji povezanost između veličine retencije totalnih proteza i testa mastikatorne efikasnosti.

Pomoću primjenjenog testa mastikatorne efikasnosti, koji je 1965 god. uveo Nikšić,¹ izvršilo se ispitivanje mastikatorne efikasnosti, dok se retencija proteza ispitivala vagom posebne konstrukcije, te se na osnovu veličine dobijene retencije i izmjerene površine baze proteze, izračunavala specifična retencija, odnosno retencija po jedinici površine, izražena u N/cm².

Iz dobivenih rezultata moglo se zaključiti da primjenjeni test mastikatorne efikasnosti može poslužiti u evidenciji funkcionalne vrijednosti totalnih proteza, a dobivena vrijednost od 61.95% pokazuje dobru funkcionalnu sposobnost ispitivanih proteza.

Ispitivanje korelacije između retencije proteza i veličine protezne baze pokazalo je pozitivnu korelaciju, jače izraženu za varijable donje totalne proteze.

Specifična retencija gornje totalne proteze pokazala je pozitivnu, slabije izraženu korelaciju sa TME, dok specifična retencija donje totalne proteze nije pokazala korelaciju sa TME.

Korelacija između dobi pacijenata i retencije proteza pokazala je vrijednosti negativnog predznaka sa malom signifikantnošću, koja je izražajnije kod žena.

Ovi nalazi potvrđuju naše kliničko iskustvo i sugeriraju da, naročito kod donje totalne proteze, samo optimalna suradnja svih utjecajnih faktora može rezultirati zadovoljavajućom funkcijskom sposobnošću totalnih proteza.