Coll. Antropol. **34** (2010) 3: 1051–1056
Original scientific paper

Decreasing of Residual Alveolar Ridge Height in Complete Denture Wearers. A Five Year Follow up Study

Ivan Kovačić[1], Asja Čelebić[2], Dubravka Knezović Zlatarić[2], Nikola Petričević[2], Dino Bukoić[2], Petar Bitanga[1], Branimira Mikelić[1], Antonija Tadin[1], Ketij Mehulić[2] and Marina Ognjenović[2]

[1] School of Medicine, Study of Dental Medicine, Split University, Split, Croatia
[2] Department of Prosthodontics, School of Dental Medicine, Zagreb University, Zagreb, Croatia

A B S T R A C T

The resorption of the residual alveolar ridges is a chronic and continuous process of bone remodeling. The aim of this study was to analyse the rate of residual ridge resorption at different sites in the both jaws in complete denture wearers, through a five-year period of denture wearing. Residual ridge changes were measured on successive lateral cephalograms at 5 measurement points of the maxilla and the mandible. The first lateral radiograph was obtained at the delivery of complete dentures. The second lateral cephalogram was obtained after five years of denture wearing. Measurements were performed using a calibrated grid. The results of this study showed the existence of a significant alveolar ridge resorption at all five measurement points of the maxilla and the mandible. The observed variables, such as body mass index and the night time denture wearing had no significant influence on the rate of residual alveolar ridge resorption ($p>0.05$). The duration of edentulousness had a significant influence on the rate of residual ridge resorption with significantly higher amounts of alveolar bone height decrase in those patients who had lost the last remaining teeth more recently.

Key words: *residual ridge resorption, complete denture, body mass index, duration of edentulousness, night time wearing of dentures*

Introduction

Residual ridge resorption (RRR) is a chronic, progressive and cumulative multifactorial process of bone remodeling[1–4]. Bone loss is greater during the first few months after the tooth extraction than later, since it slows down with time after extraction[5–8]. It leads to the insufficient support for the proper functioning of removable complete dentures[9]. The factors that affect the RRR are still not completely elucidated. Some studies described a correlation between 63 different factors and ridge resorption[10–12]. Some sistemic factors that could possibly be related with RRR are: nutrition (Ca and vitamin D), hormonal imbalance[5], metabolic bone diseases, hormonal or drug intake, age, gender, etc.[13–15].

Local factors associated with the RRR may be a quality, size and a shape of a residual ridge after the extraction of teeth, denture wearing habits, loading of alveolar ridges following tooth loss, quality of dentures, stability of dentures, duration of edentulousness, incorrect horizontal and vertical jaw relation, nighttime wearing of dentures, reduced masticatory forces in denture wearers, etc.[16,17].

The ratio of mandibular to maxillary RRR increases to 4:1 after 7 years of complete dentures wearing[6–8,15]. It has been assumed that different amounts of trabecular and cortical bone in the maxilla and the mandible probably play a role in determining how sensitive the structures would be to the various systemic and local factors[18]. The trabecular bone in the maxilla may absorb occlusal forces more efficiently than the cortical bone in the mandible. The aetiology of residual ridge resorption is still not fully understood. Despite listing of many factors responsible for the residual ridge resorption, a single domi-

Received for publication July 10, 2009

nant factor has not yet been determined, possibly due to the fact that RRR has been caused by a combination of local and systemic factors.

The aim of this study was to examine the rate of residual ridge resorption in edentulous patients through the five years of denture wearing. The aim was also to examine the influence of body mass index, nighttime wearing of dentures and duration of edentulousness on the amount of RRR.

Materials and Metods

Subjects

A total of 47 eugnath completely edentulous individuals who had received new complete dentures (complete denture wearers, CDWs) were included in the study. There were 18 male patients (mean age 63 years, age range 53 to 81 years) and 29 female patients (mean age 69 years, age range 51 to 84 years). All the patients received their new complete dentures at the Department of Prosthodontics, Dental Polyclinic Split. The Ethics Committee of the Dental Polyclinic Split and the School of Dental Medicine, Zagreb University approved this study. All the dentures were made using a face bow transfer for mounting the casts in semiadjustable articulator. The vertical and horizontal jaw relation had been checked by swallowing and phonetic tests. At the stage of denture delivery the occlusion was checked and adjusted if neccessary, retention and stability of both dentures had also been verified. Only patients whose dentures had been verified as excellent were included in the study. During the five-year observation period the dentures had not been relined. Finally, only 31 patients [13 males (mean age 64 years, age range 58 to 80 years) and 18 females (mean age 68 years, age range 56 to 83 years)] completed the exemination.

The body mass index of each subject was calculated by dividing the weight (kg) of the subject by the square of their height (m^2). The patients were divided into two groups based on the body mass index (BMI). The first group consisted of patients with BMI<24.5 kg/m^2 and the second group were patients with BMI>24.5 kg/m^2.

Patients were also divided into two groups based on a day-time and a day+night-time of denture wearing (7 patients had been wearing dentures day+night time and 24 patients had been wearing dentures only during day--time).

At the baseline of the study, the CDWs were divided into three groups dependent on the time elapsed from the last tooth extraction (1 ≤ one year, 2 = 1–10 years and 3 ≥ 10 years).

Radiography

Radiographic measurments were made on lateral cephalometric radiographs. The first lateral cephalogram was made at the delivery of complete dentures and the second one five years after the denture placement. Lateral cephalograms were obtained with the dentures in the mouth in the position of the maximum intercuspation during exposure. All radiographs were made using the same equipment (Siemens Roentgen Kugel 2E; Munich, Germany) with a constant current of 15 mA and 70 kV. Exposure varied from 1.2 to 1.6 s, depending on the constitution of the patient. The same cephalostat was used during exposure, so that the Frankfurt horizontal plane (tragion-orbitale) was parallel to the horizontal plane, and the mediosagittal plane was perpendicular to the horizontal plane.

Fig. 1. Maxillary linear vertical resorption measurement.

The linear vertical resorption of the maxillary and mandibular residual alveolar ridge was determined as the difference in height of the alveolar process during the two stages of observation.The measurements of the vertical height of maxillary residual ridges were performed by means of two horizontal and ten vertical planes on a calibrated grid. The horizontal line of the calibrated grid was orientated over the palatal plane (Sna-Snp). The first reference point was the intersection point of the first perpendicular line and maxillary alveolar crest ridge (U1). Successive reference points were placed at a dis-

Fig. 2. Mandibular linear vertical resorption measurement.

tance of 1 cm from each other at the intersection of the perpendicular lines and alveolar process (U2-U5). Each perpendicular line of the grid had graduations of 0.2 mm (Figure 1). To measure the height of the mandiblular alveolar ridge, the horizontal line of the grid was orientated parallel to the mandibular line (Gn-Go) and the first reference point was the intersection of the first perpendicular line and the crest of the mandibular alveolar process (L1) and successive reference points were placed 1 cm from each other at the intersection of the perpendicular lines and the alveolar process (L2-5) (Figure 2). In cases with two alveolar outlines on the lateral radiogram, the midpoint between the two lines was measured.

Statistical analysis

The data were analyzed with a statistical software SPSS for Windows 12 (SPSS Version 12.0; SPSS Inc, Chicago, Ill). The following statistical methods were used:

- Standard descriptive statistic
- T-test for related samples
- T-test for independent samples
- Analysis of variance-one way ANOVA

The level of significance was set at 95% probability ($p<0.05$).

TABLE 1
COMPARAISON OF VERTICAL HEIGHT OF ALVEOLAR RIDGES

Measurement point	First measurement (mm) (SD)	Measurement after 5 years (mm) (SD)	Difference between the first and second measurement (mm) (SD)
U1	17.10 (3.95)	15.92 (3.84)	1.18 (0.70)*
U2	16.13 (3.69)	15.16 (3.65)	0.97 (0.68)*
U3	16.27 (3.26)	15.55 (3.36)	0.73 (0.79)*
U4	15.27 (2.68)	14.52 (2.57)	0.75 (0.88)*
U5	14.33 (2.79)	14.05 (2.65)	0.28 (0.36)*
L1	25.15 (6.30)	22.74 (6.01)	2.41 (1.22)*
L2	21.50 (6.89)	19.63 (6.76)	1.87 (1.18)*
L3	19.02 (7.22)	17.56 (6.52)	1.46 (1.29)*
L4	19.23 (6.27)	18.42 (5.83)	0.81 (0.93)*
L5	23.90 (5.13)	23.55 (4.94)	0.35 (0.56)*

t-test for related samples
*= $p<0.05$

Results

At the baseline 47 patients were included in this research. At the 5-year check-up 16 patients had not responded and the second radiograph had not been ob-

TABLE 2
INFLUENCE OF NIGHT TIME WEARING OF DENTURES AND BODY MASS INDEX ON RESIDUAL RIDGE RESORPTION

	Night time wearing of dentures			Body mass index (kg/m^2)		
		$\overline{X}$ (SD)	p		$\overline{X}$ (SD)	p
U1	No	1.21 (0.66)	0.40	<24.5	1.00 (0.79)	0.45
	Yes	0.88 (0.85)		>24.6	1.25 (0.62)	
U2	No	1.00 (0.68)	0.51	<24.5	0.55 (0.58)	0.015 *
	Yes	0.75 (0.64)		>24.6	1.25 (0.58)	
U3	No	0.71 (0.90)	0.86	<24.5	0.67 (0.96)	0.91
	Yes	0.63 (0.47)		>24.6	0.71 (0.75)	
U4	No	0.64 (0.87)	0.82	<24.5	0.38 (0.48)	0.15
	Yes	0.75 (0.50)		>24.6	0.87 (0.95)	
U5	No	0.23 (0.35)	0.82	<24.5	0.11 (0.22)	0.16
	Yes	0.25 (0.28)		>24.6	0.33 (0.38)	
L1	No	2.09 (0.98)	0.13	<24.5	2.00 (1.06)	0.34
	Yes	3.13 (1.9)		>24.6	2.50 (1.34)	
L2	No	1.58 (0.98)	0.59	<24.5	1.66 (0.96)	0.55
	Yes	3.00 (1.91)		>24.6	2.00 (1.5)	
L3	No	1.21 (1.25)	0.47	<24.5	0.50 (0.66)	0.0106*
	Yes	1.75 (1.65)		>24.6	1.92 (1.3)	
L4	No	0.61 (0.91)	0.30	<24.5	0.33 (0.35)	0.055
	Yes	1.12 (0.47)		>24.6	1.00 (1.02)	
L5	No	0.26 (0.53)	0.96	<24.5	0.06 (0.16)	0.081
	Yes	0.25 (0.50)		>24.6	0.42 (0.63)	

t-test for independent samples
*= $p<0.05$

tained (11 patients died, it was not possible to find 2 patients as they moved away, and 3 patients had not been wearing dentures during the observed period). Finally, only 31 patients completed the exemination.

There was no significant difference between gender ($p>0.05$) and the results are presented for the whole sample.

The mean values (x) and standard deviations (SD) of the alveolar height and the mean reduction and standard deviations of the amount of residual ridge resorption of the maxilla and the mandible are shown in Table 1. Results show statistically significant differences of ridge height at all of the five measurement points after the five year denture wearing period. In all CDWs alveolar ridge height significantly decreased ($p<0.05$).

Influence of night time wearing of dentures and influence of BMI on residual ridge resorption is shown in Table 2. Statistical analysis revealed no significant differences between patients who had been wearing their dentures by day and by night and patients who had been wearing their dentures only by day. There was no significant differences between two groups of patients with different BMI except for the measurement points U2 and L3.

The significance of the differences in the resorption of the alveolar ridges among the three groups of patients with different duration of edentulousness prior complete denture delivery is shown in Table 3. The results show significantly higher rate of residual ridge resorption at the U1, U3, U5 and L1 measurement points in those CDWs who had been edentulous for a shorter period of time.

Discussion

The results of this study revealed statistically significant rate of RRR at all five referent points of measure-

TABLE 3
INFLUENCE OF DURATION OF EDENTULOUSNESS ON RESIDUAL RIDGE RESORPTION

Measurement point	Time of edentulousness	$\overline{X}$	SD	F	p
	< 1 year	1.50	0.408		
U1	1–10 year	1.60	0.652	3.545	0.050 *
	> 10 year	0.83	0.651		
	< 1 year	1.250	0.2887		
U2	1–10 year	1.300	0.9083	2.069	0.155
	> 10 year	0.708	0.5823		
	< 1 year	1.38	1.181		
U3	1–10 year	1.30	0.671	8.133	0.003 **
	> 10 year	0.21	0.334		
	< 1 year	1.125	0.4787		
U4	1–10 year	1.000	1.4142	2.023	0.161
	> 10 year	0.375	0.4330		
	< 1 year	0.375	0.4787		
U5	1–10 year	0.500	0.3536	3.957	0.038 *
	> 10 year	0.083	0.1946		
	< 1 year	2.63	0.479		
L1	1–10 year	3.80	1.440	3.957	0.038 *
	> 10 year	1.54	0.498		
	< 1 year	1.500	0.4082		
L2	1–10 year	3.400	1.4318	3.957	0.038 *
	> 10 year	1.333	0.8876		
	< 1 year	1.75	1.323		
L3	1–10 year	2.50	1.620	5.388	0.015 *
	> 10 year	0.67	0.718		
	< 1 year	1.000	0.7071		
L4	1–10 year	1.500	1.1726	5.419	0.014 *
	> 10 year	0.292	0.4502		
	< 1 year	0.38	0.479		
L5	1–10 year	0.40	0.894	0.455	0.642
	> 10 year	0.17	0.326		

Analysis of variance – one way ANOVA
*= $p<0.05$

ments in the maxilla (U1-U5) and the mandible (L1-L5) through the five years of denture wearing. Dentures likely do not give adequate functional stimulation to the bone as do natural teeth. Moreover, compressive forces have been transmitted via dentures to the denture bearing area[24]. The decrease of proprioceptive perception due to the lost of periodontal receptors during chewing can cause overloading of denture bearing tissue which may result in higher resorption rate. Ill fitting denture and/or parafunctional activity can provoke higher rates of RRR[25].

Tallgren[15] found that the mean reduction in ridge height of the mandible following tooth extraction was twice that of the maxilla during the 1st year period. The ratio of mandibular to maxillary resorption increased further, to approximately ratio of 4:1 after 7 years of edentulousness[7,19]. The results of this study showed that the rate of resorption was almost twice more pronounced in the mandible than in the maxilla after the five-year period of complete denture wearing. The mandibular ridge is more likely to bear higher functional forces transmitted through the dentures than the maxillary ridge. The most likely reason is the smaller area and less advantageous shape of the lower basal seat. In regard to the less marked resorption of the maxillary alveolar ridge, the resistance offered by the hard palate to forces transmitted through the maxillary dentures to the denture bearing area may play an important part[15].

The results of this study also show higher amount of RRR in the anterior part of the maxilla and the mandible than in the posterior parts. Higher amount of resorption in frontal regions of the both jaws may be explained by the fact that the last remaining teeth are usually frontal teeth and the rate of alveolar bone loss has been highest during the first year of edentulousness[7,19].

In the present study, daytime and daytime plus night time denture wearing had no influence on the rate of RRR during the five years of denture wearing ($p>0.05$). According on some previous research, denture wearing jaws lost more bone than those without dentures[20–22]. Therefore, the removal of dentures during night-time might reduce bone resorption. Blood circulation in undelying mucosal and alveolar bone tissue may be better if the dentures have not been worn during sleeping period[23,24]. This study has not proved above mentioned facts.

The results of this study also showed that there was no statistically significant differences in the rate of alveolar ridge resorption between subjects with different body mass index. The size of an individual (BMI) may have an influence on the ridge resorption. After the age of 40, BMI of the skeleton decreases, so by the age of 65 about one-third of the bone minerals have been lost[26,27]. Decreased physical activity, lowered secretion of estrogen, diet, race and heredity may all play a role in age-related bone loss[28]. This study did not show difference in alveolar bone loss probably due to the fact that all individuals had BMI within normal limits, and some of the patients had been overweighted.

The findings of this study also showed significantly higher rate of RRR in patients who have been edentulous for a shorter period of time (<1 year, 1–10 years) prior the new denture delivery. It was expected that the highest amount of residual alveolar ridge resorption would be found in patients edentulous for a shorter period of time, and the hypothesis has been confirmed. However, this study showed similar amount of the alveolar height loss in patients edentulous less than one year and patients edentulous more than one year. It may be explained as follows: resorptive changes may be localized at different sites of the alveolar ridge after the tooth loss. When localized at the alveolar crest, the height will be decreasing gradually. However, the greatest amount of the loss of alveolar bone can be located bucally or lingually and in such cases the height of alveolar ridge changes slowly during the first years, although the ridge becomes thinner. However, the resorption is the fastest during the first few years after teeth extractions and it slows down gradually over time. However, some activity can be detected even after 25 years of constant denture wearing[15]. Some autors found out that the RRR stoped after ten years in the maxillary jaw, while it was continous in the mandible[29].

Considering RRR, there have been no statistically significant differences between the gender in the present study, although some previous studies[5,13] found associations between female gender and RRR.

High individual variation of RRR in CDWs usually can not be fully understood. The ability to predict which patients are likely to lose a greater amount of bone is important for clinical treatment planning, as they might be candidates for implant overdenture treatment, at least in the mandibular edentulous jaw, which shows higher RRR than the maxillary jaw.

REFERENCES

1. ATWOOD DA, J Prosthet Dent, 26 (1971) 266. — 2. ATWOOD DA, J Prosthet Dent, 12 (1962) 441. — 3. MERCIER P, LAFONTAN R, J Prosthet Dent, 41 (1979) 90. — 4. NISHIMURA J, HOSOKAWA R, ATWOOD DA, J Prosthet Dent, 67 (1992) 820. — 5. XIE O, AINAMO A, TILVIS R, Acta Odontol Scand, 55 (1997) 299. — 6. TALLGREN A, Acta Odontol Scand, 24 (1966) 195. — 7. TALLGREN A, Acta Odontol Scand, 25 (1967) 563. — 8. TALLGREN A, Acta Odontol Scand, 28 (1970) 251. — 9. KLEMETTI E, J Prosthet Dent, 75 (1996) 512. — 10. WOELFEL JB, WINTER CH, IGARASHI T, J Prosthet Dent, 36 (1976) 602. — 11. KRIBBS PJ, CHESNUT CH, OTT SM, KILCOYNE RF, J Prosthet Dent, 62 (1989) 703. — 12. KRIBSS PJ, SMITH DE, CHESNUT CH, J Prosthet Dent, 50 (1983) 576. — 13. DE BAAT C, KALK W, VAN HOF MA, Community Dent Oral Epidemiol, 21 (1993) 317. — 14. NAHRI TO, ETTINGER RL, LAM EW, Int J Prosthodont, 10 (1997) 183. — 15. TALLGREN A, J Prosthet Dent, 27 (1972) 120. — 16. DEVLIN H, FERGUSON MWJ, Br Dent J, 170 (1991) 101. — 17. KOVACIC I, CELEBIC A, KNEZOVIC-ZLATARIC D, STIPETIC J, PAPIC M, Coll Antropol, 27 (2003) 69. — 18. KLEMETTI E, KROGER H, LASSILA V, J Oral Rehabil, 24 (1997) 808. — 19. TALLGREN A, Acta Odont Scand, 27 (1969) 539. — 20. ISMAI Y, SATO T, MORI S et al, J Oral Rehabil, 29 (2002) 72. — 21. MORI S, SATO T, HA-

RA T, NAKASHIMA K, MINAGI S, J Oral Rehabil, 24 (1997) 37. — 22. KELSEY CC, J Prosthet Dent, 25 (1971) 152. — 23. CAMPBELL RL, JADA, 60 (1960) 143. — 24. JOZEFOWITCZ W, J Prosthet Dent, 24 (1970) 137. — 25. BERGMAN B, CARLSSON GE, ERICSON S, Scand J Dent Res, 79 (1971) 449. — 26. GORDAN GS, GENANT HK, Clin Geriatr Med, 1 (1985) 95. — 27. ZLATARIC DK, CELEBIC A, KOBLER P, J Gerontol A Biol Sci Med Sci, 57 (2002) 588. — 28. KROLNER B, TOFT B, Clin Sci, 64 (1983) 537. — 29. DOUGLASS JB, MEADER L, KAPLAN A, ELLINGER CW, J Prosthet Dent, 69 (1993) 270.

I. Kovačić

Split Dental Polyclinic, Matoševa 2, 21000 Split, Croatia
e-mail: ivan.kovacic4@st.t-com.hr

SMANJENJE VISINE REZIDUALNOG ALVEOLARNOG GREBENA U NOSILACA POTPUNIH PROTEZA. PETOGODIŠNJA STUDIJA

S A Ž E T A K

Resorpcija rezidualnog grebena je kronični i kontinuirani proces remodelacije kosti. Svrha ovog istraživanja bila je analizirati iznos resorpcije rezidualnog grebena na različitim područjima obje čeljusti, na postraničnim telerengenogramima kod nosilaca potpunih proteza tijekom razdoblja od pet godina. Promjene rezidualnog grebena mjerene su pomoću kalibrirane mrežice na pet mjernih točaka maksile i mandibule prilikom predaje proteza i nakon pet godina nošenja. Rezultati ovog istraživanja pokazuju postojanje značajne resorpcije grebena maksile i mandibule u svim mjernim točkama. Promatrane varijable kao što su indeks mase tijela i nošenje proteza noću nemaju značajan utjecaj na iznos resorpcije. Značajan utjecaj na resorpciju grebena ima trajanje bezubosti.