

# Alveolar Ridge Resorption as Detected on Panoramic Radiographs

Resorpcija alveolarnoga grebena utvrđena na ortopantomogramima

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## Summary

*This study was conducted to determine the relationship of the center of the mental foramen to the inferior (IM – CM) and superior borders (CM – SM) of the mandible, as reference points on panoramic radiographs in different groups according to sex, age and loss of teeth, to elucidate some of the factors contributing to alveolar ridge resorption.*

*Measurements of 564 images (left and right sides) on 282 panoramic radiographs revealed the mental foramen to be nearer to the lower border of the mandible ( $p < 0.05$ ). There was no significant difference for IM – CM distances between the groups with different number of teeth and of different age in either men and women ( $p > 0.05$ ), indicating this part of the mandible to remain relatively constant in size, despite increasing age, loss of teeth and occurrence of postmenopausal osteoporosis in women.*

*In women the mandible was found to be significantly smaller for both measured distances (IM – CM, and CM – SM) than in men ( $p < 0.01$ ), which was an expected finding, as women in general have smaller skeleton. In CM – SM measurements there was a significant difference ( $p < 0.01$ ) between the dentulous and fully edentulous groups in both men and women, indicating the importance of tooth preservation and suggesting the complete loss of teeth to be the main factor of alveolar bone resorption.*

**Key words:** panoramic radiographs, mandibular corpus, mental foramen, alveolar ridge resorption.

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## Introduction

Alveolar ridge resorption is a considerable problem in prosthodontic reconstructive treatment. When considered in terms of socioeconomic impact, residual ridge resorption is in the

same category as dental caries and periodontal disease (1).

The bone has been remodeled and reshaped throughout life and many systemic and/or local factors may influence this process. Although it is certain that the loss of teeth triggers this phe-

nomenon, the influence of local and systemic factors on the rate of residual ridge resorption has not yet been completely elucidated (2, 3).

Parathyroid gland controls the dissolution of bone for the provision of calcium, so that serum concentration could be maintained within very close tolerances, because calcium is involved in the transmission of nerve impulses, the regulation of cardiac function and the blood clotting mechanism (11). Some experiments conducted on dogs have revealed that, when skeletal depletion of calcium occurs as a result of stimulation of parathyroid gland, alveolar bone is first affected, the ribs and vertebrae second and long bones third (14).

Age-related osteopenia is the decrease in bone mass per unit volume of the skeleton with advanced age (11), and begins after approximately 35 years of age and continues throughout the life. There is an acceleration of this process in women at the onset of menopause (11). Long-term studies on residual ridge resorption in complete denture wearers revealed pronounced changes in jaw and occlusal relationship due to marked resorption in the first year after the teeth had been extracted and the dentures delivered to the patient (10). Resorption continued in the next ten years at the rate of about 1 mm per year (10,15). In patients with overdentures resorption was significantly smaller (16,17).

Resorption of the mandibular ridge is a clinical index of bone response in prosthodontic patients. In the modern world more and more individuals are forced to use artificial teeth due to the prolonged life span. As part of the pretreatment examination, the increasing use of panoramic radiographs of the jaws has made additional diagnostic data available. Panoramic radiographs provide a graphic picture of maxillary and mandibular bone, and in the edentulous patients the only remaining radiographic landmarks in the mandibular corpus are the superior and inferior borders of the mandible and the mental foramen.

The aim of the present study was to examine the influence of some factors, such as age, sex and extraction of the teeth on the amount of mandibular bone resorption by using the distances from the center of the mental foramen to the inferior and superior borders of the lower jaw as reference points on panoramic radiographs.

## Materials and Methods

In total, 282 panoramic radiographs from the files of the School of Dentistry, University of Zagreb, were selected for the purpose of measurements according to the following criteria: 1) radiographic images of mental foramen and the borders of the mandible had to be distinct; 2) the image of the mandible must not be grossly distorted; 3) only films of adult patients with developed jaws could be used; 4) both the left and right side of the film had to meet the preceding criteria.

Viewing was done on a standard view box illuminated with fluorescent bulbs. Measurements were made with a precise calliper in perpendicular direction to the horizontal axes of the body of the mandible. In total, 564 sets of measurements were recorded, from the inferior border of the mandible to the center of the mental foramen (IM-CM distance) and from the center of the mental foramen to the superior border of the alveolar bone of the mandible (CM-SM distance). Data were obtained separately for men and women and were divided into 3 groups according to the presence of the teeth: group I – all the teeth were present and in normal relationship (dentulous), group II – partially edentulous, with at least one premolar present on each side, and group III – fully edentulous individuals, without severe alveolar ridge resorption.

The average age of group I was 29.5 years in females (from 21 to 40 years) and 30.2 years in males (24-43 years). The mean age for group II was 39.7 years in females (26-51 years) and 39.4 years in males (28-54 years). For group III, the mean age was 66.7 years in females (52-74 years) and 64.5 in males (54-73 years).

The means and standard deviations were calculated for each group and the data from the respective groups compared using the t-test.

## Results

Location of the center of the mental foramen in relation to the inferior (IM-CM) and superior borders of the mandible (CM-SM) is shown in Table 1 for men and in Table 2 for women for all examined groups (dentulous, partially edentulous and fully edentulous). In all the examined groups CM-SM distance was bigger than IM-CM distance, which was significant at the

Table 1. Mandibular height distances (in millimeters) in relation to the center of the mental foramen in males

Tablica 1. Vrijednosti visine mandibule (u mm) u odnosu prema sredini mentalnog foramena kod muških ispitanika

VARIABLE	GROUP	N	IM-CM		CM-SM	
			X (mm)	sd	X (mm)	sd
	I	130	15.4	2.3	20.3	2.9
	II	86	16.4	2.5	19.2	3.2
	III	74	15.7	2.6	18.7	3.0

IM-CM distance (inferior border of the mandible to the center of the mental foramen)

CM-SM distance (center of the mental foramen to the superior border of the mandible)

Group I - dentulous individuals

Group II - partially edentulous individuals

Group III - fully edentulous individuals

(IM-CM) > (CM-SM) for  $p > 0.05$

Table 2. Mandibular height distances (in millimeters) in relation to the center of the mental foramen in females

Tablica 2. Vrijednosti visine mandibule (u mm) u odnosu prema sredini mentalnog foramena kod ženskih ispitanika

VARIABLE	GROUP	N	IM-CM		CM-SM	
			X (mm)	sd	X (mm)	sd
	I	92	13.9	2.8	18.2	2.5
	II	80	13.6	2.3	17.2	2.7
	III	102	14.2	2.0	16.9	3.4

IM-CM distance (inferior border of the mandible to the center of the mental foramen)

CM-SM distance (center of the mental foramen to the superior border of the mandible)

Group I - dentulous individuals

Group II - partially edentulous individuals

Group III - fully edentulous individuals

(IM-CM) > (CM-SM) for  $p > 0.05$

level of 95%. The level of significance between sexes for IM-CM and CM-SM distance in all the three groups is shown in Table 3. The diffe-

rence was significant for all the measured parameters ( $p < 0.01$ ).

The level of significance between edentulous and dentulous individuals in males and females is shown in Tables 4 and 5, as well as the level of significance between dentulous and partially edentulous, and partially edentulous and fully edentulous, respectively.

Table 3. Level of significance for variables (IM-CM) and (CM-SM) between sexes for all three groups

Tablica 3. Razina značajnosti za varijable (IM-CM) i (CM-SM) među spolovima za sve tri skupine

VARIABLE	GROUP	IM-CM	CM-SM
		I	$p < 0.01$
II	$p < 0.01$	$p < 0.01$	
III	$p < 0.01$	$p < 0.01$	

IM-CM distance (inferior border of the mandible to the center of the mental foramen)

CM-SM distance (center of the mental foramen to the superior border of the mandible)

Group I - dentulous individuals

Group II - partially edentulous individuals

Group III - fully edentulous individuals

Table 4. Level of significance for (IM-CM) and (CM-SM) distances between groups I and III; I and II; II and III, for males

Tablica 4. Razina značajnosti za Im-CM i CM-SM razmake među skupinama I i III; I i II; II i III za muške ispitanike

VARIABLE	GROUP		
	I / III	I / II	II / III
IM-CM	$p > 0.05$	$p > 0.05$	$p > 0.05$
CM-SM	$p < 0.05$	$p > 0.05$	$p > 0.05$

IM-CM distance (inferior border of the mandible to the center of the mental foramen)

CM-SM distance (center of the mental foramen to the superior border of the mandible)

Group I - dentulous individuals

Group II - partially edentulous individuals

Group III - fully edentulous individuals

Table 5. Level of significance for (IM-CM) and (CM-SM) distances between groups I and III; I and II; II and III, for females

Tablica 5. Razina značajnosti za Im-CM i CM-SM razmake među skupinama I i III; I i II; II i III za ženske ispitanike

VARIABLE	GROUP		
	I / III	I / II	II / III
IM-CM	$p > 0.05$	$p > 0.05$	$p > 0.05$
CM-SM	$p < 0.01$	$p > 0.01$	$p > 0.01$

IM-CM distance (inferior border of the mandible to the center of the mental foramen)

CM-SM distance (center of the mental foramen to the superior border of the mandible)

Group I - dentulous individuals

Group II - partially edentulous individuals

Group III - fully edentulous individuals

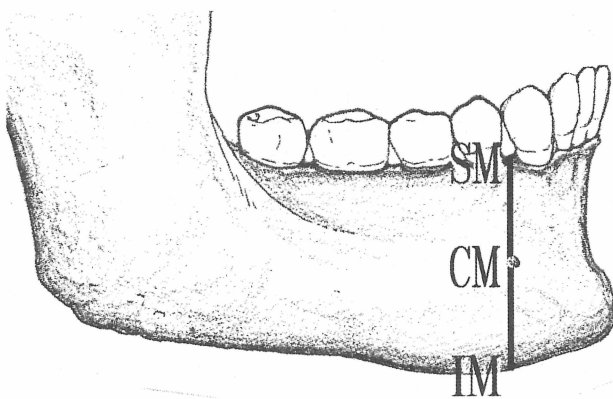


Figure 1. Measurements of IM - CM and CM - SM distances

IM - inferior border of the mandible

CM - center of the mental foramen

SM - superior border of the mandible

Slika 1. Mjerenja IM - CM i CM - SM udaljenosti

IM - donji rub mandibule

CM - centar foramena mentale

SM - gornji rub mandibule

The only significant difference ( $p < 0.01$ ) was that between dentulous and fully edentulous individuals for CM-SM measurements. There was no significant difference between the examined groups for IM-CM measurements ( $p > 0.05$ ) (Tables 4,5).

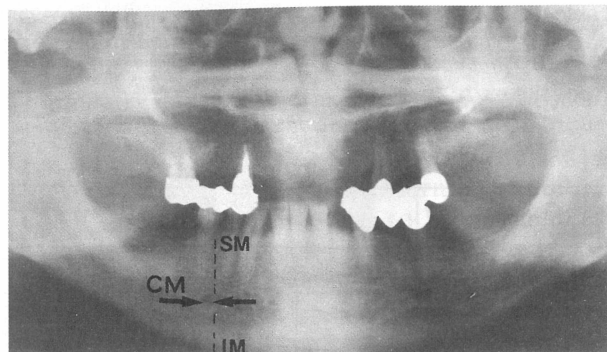


Figure 2. Measurements of IM - CM and CM - SM distances on a panoramic radiograph of partially edentulous mandible

IM - inferior border of the mandible

CM - center of the mental foramen

SM - superior border of the mandible

Slika 2. Mjerenja IM - CM i CM - SM udaljenosti na ortopantomogramu parcijalno bezube mandibule

IM - donji rub mandibule

CM - centar foramena mentale

SM - gornji rub mandibule

## Discussion

Residual ridge resorption is a result of alveolar remodeling under the influence of local and systemic factors after teeth extraction. It follows a chronic, progressive and irreversible course and sometimes results in severe impairment of prosthetic restoration and oral function. The pathogenesis of residual ridge resorption (RRR) has not yet been completely elucidated.

As the mental foramen is a stable anatomic and radiographic landmark, even in the edentulous jaws, the distances from the inferior border of the mandible to the center of the mental foramen (IM-CM) and from the center of the foramen to the superior border of the mandible (CM-SM) were measured in men and women divided in dentulous (I), partially edentulous (II) and fully edentulous (III) groups.

There was no significant difference for IM-CM distance between groups I and II, I and III and II and III ( $p > 0.05$ ) (Table 4 for men and Table 5 for women), which indicates that the bone of the lower part of the mandible is not significantly affected by resorption. Even the possible influence of postmenopausal bone loss in females could not be confirmed upon the bone under the mental foramen, because there was no sig-

nificant difference between III and I, or III and II female groups ( $p > 0.05$ ), as group III females were on an average aged 66.7 years, and the onset of menopause is supposed to be at 55 years of age (11). This result proved Wical and Swope's assumption (12,18), that the distance below the inferior border of the mental foramen as a constant, in ratio with the total height of the mandibular corpus, could be an index of the severity of bone resorption. Using the approximate ratio of 1:3, the authors suggest that the original height of the mandible before resorption could be estimated and the classification was to be limited to proportional divisions since panoramic radiographs show magnified images.

Some anatomy texts place the mental foramen about halfway between the inferior and superior border of the mandible (19), which was not the finding of this study. Mental foramen is situated significantly nearer to the inferior border of the mandible, both in men and women (Tables 1 and 2) in all the groups examined, even in the fully edentulous individuals.

The data in the Table 1,2 and 3 indicate a significant difference between men and women in IM-CM and CM-SM measurements in all groups ( $p < 0.01$ ). Although not discussed in literature, it is not a surprising finding, as women in general have a smaller skeleton and 30% less bone mass than men (11). Smaller IM-CM values in women are in agreement with the findings of Orthman (21).

Considering CM-SM measurements, significant difference was found between dentulous (I) and fully edentulous (III) groups ( $p < 0.01$ , Tables 4,5), while the difference was not significant either between I and II, or II and III groups ( $p > 0.05$ , Tables 4,5) in both men and women. This result indicates that alveolar bone

resorption is a gradual process dependent on the loss of teeth and the removal of all teeth is a main factor contributing to alveolar bone resorption. Teeth preservation appears to be the most important factor in bone resistance to resorption.

The influence of some local factors, such as wearing dentures and period of being edentulous on residual ridge resorption (RRR) have not been examined in this study and future research will be focused on it.

## Conclusions

1. Mental foramen is nearer to the inferior border of the mandible in dentulous (I) and partially edentulous (II), as well as in fully edentulous (III) groups of individuals without extreme resorption of residual alveolar ridge.

2. The mandibles in women are significantly smaller than in men for the examined IM-CM and CM-SM distances ( $p < 0.01$ ).

3. There is no significant difference for IM-CM distances between the groups with different number of the teeth and different age, in either men or women, which indicates that the lower part of the mandible does not undergo resorption despite increasing age, loss of teeth and occurrence of menopause in women.

4. The significant difference in CM-SM distances ( $p < 0.01$ ) between dentulous and fully edentulous groups in men and women is due to complete loss of teeth as a main factor of alveolar ridge resorption and indicates therefore the importance of tooth preservation.

5. The amount of the alveolar bone loss in the CM-SM distance is a valuable indicator for the rebuilding of the artificial alveolar ridge in the construction of the base of the complete lower denture.

## RESORPCIJA ALVEOLARNOGA GREBENA UTVRĐENA NA ORTOPANTOMOGRAMIMA

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### Sažetak

Cilj ovoga rada bio je odrediti odnos od centra foramena mentale, koji je referentna točka na ortopantomogramima, do donjega (IM – CM) i gornjega (CM – SM) ruba mandibule, u različitim ispitanika podijeljenih u skupine po spolu, dobi i gubitku zuba.

Mjerenja su izvršena na 282 ortopantomograma (564 mjerenja). Rezultati su pokazali da je foramen mentale bliže donjem rubu mandibule ( $p > 0,05$ ) i kod muških i kod ženskih ispitanika. Za udaljenost od centra foramena mentale do donjeg ruba mandibula (IM – CM) nije bilo statistički značajne razlike ( $p > 0,05$ ) između ispitanika različite dobi i različitog gubitka zubi, što ukazuje da se ovaj dio mandibule ne resorbira, bez obzira na dob, gubitak zuba ili nastanak postmenopauzalne osteoporoze u žena.

Mandibula je kod žena bitno manja nego kod muškaraca za obje udaljenosti (IM – CM i CM – SM) ( $p < 0,01$ ), što je i očekivani rezultat, jer žene imaju općenito slabije razvijen skelet.

Za udaljenost od centra foramena mentale do gornjeg ruba mandibule (CM – SM) postojala je statistički značajna razlika između ozubljenih i potpuno bezubih ispitanika i kod ženskog i kod muškog spola ( $p < 0,05$ ), što pokazuje da je potpuni gubitak zuba glavni etiološki faktor prilikom resorpcije alveolarnog nastavka i da je važno sačuvati zube prilikom izrade protetskih nadomjestaka.

Ključne riječi: ortopantomogrami, tijelo mandibule, foramen mentale, resorpcija alveolarnoga grebena

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