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Changes of Alveolar Bone Density Around the Abutment Teeth in Patients Wearing Removable Partial Dentures Depending on Kennedy Classification

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A B S T R A C T

The aim was to study the influence of Kennedy classification on alveolar bone density changes around the abutment teeth of removable partial denture (RPD) clasp and rests. A total of 50 examinees of both gender wearing RPDs were included in the study. Changes of bone density around the abutment teeth were determined by an intraoral microdensitometry method. Standard retroalveolar radiographs were obtained twice: the first one at the RPD delivery and the second one after a period of 3 month of denture wearing. The copper stepwedge consisting of 5 steps (0.1–0.1 mm) was attached to the radiograph prior to exposure in order to calibrate it. Seven regions of interest (ROI) in different position close to the root of the abutment tooth were selected on each radiograph, all 10 pixels in size. Grey levels of each ROI were measured and were converted into equivalents of the copper stepwedge thickness using the third degree polynomial in order to compare the difference of bone density between the two radiographs. The results indicated that Kennedy classification had no significant influence on the change of bone density in RPD patients during first 3 month of RPD wearing (ANOVA: $p>0.05$).

***Key words**: alveolar bone, intraoral microdensitometry, retroalveolar radiography, removable partial denture, Kennedy classification*

Introduction

The reduction of alveolar bone density is an individual process that depends on many sistemic (age, gender, hormonal disturbancies, osteoporosis, etc.)[1–8] and local factors (oral hygiene, masticatory stress, well planned construction of RPD, etc.)[9,10]. All the examined subjects wearing a RPD have a greater possibility of alveolar bone resorption due to a greater stress to the abutment teeth and the denture bearing area. It is well known that occlusal rests distribute masticatory forces on the abutment teeth and further through the periodontal apparatus to the alveolar bone[11]. During mouth opening, clasps prevent RPD to dislodge from the denture bearing area thus transmitting forces to tha abutment teeth in oblique directions. The forces that affect the abutment teeth in RPDs are different than in eugnatic natural dentition.

It is to be expected that bone apposition would occur in cases of higher forces directed axially to the tooth rooth[12]. In that case apposition of cement and alveolar bone, i.e. greater bone density and specific bone trabecules are to be expected[13]. On the contrary, other forces (such as the action of the retentive clasp) lead to the stress of periodontal ligament. Such forces may exceed the individual tolerance level leading to the reduction of alveolar bone density. Literature suggests that some nonphisiological components of any of the RPDs can not be completely avoided[14–16]. It has also been proven that every overload of the abutment tooth and surrounding alveolar bone, as well as poor retention and stability of the RPD lead to an increase in alveolar bone resorption[10]. In different Kennedy classification of the edentulous areas

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the position of RPD clasp and RPD rests are planned in different manner. We expected that Kennedy classes I and II (distal extensions) would show bone density reduction due to a greater representation of unfavourable forces than in Kennedy classes III and IV[17]. In Kennedy classes III and IV normally two abutment teeth receive masticatory force loads and therefore there is a lower possibility of exceeding the adaption capacity of abutment teeth.

Changes in alveolar bone density can be easily determined by comparing series of radiographs. The difference of intesity of X-radiation, different voltage and current intesity during exposure, difference in developing procedure and sensitivity of film have to be overcome[18]. Therefore stepwedges of different materials and of different tickness have been used[19–24]. Bone mineral density values are transformed into the equivalents of a stepwedge thicknes by using different mathematical methods[25,26]. The registered errors are minimal and occasional[27].

The aim of the study was to measure changes of alveolar bone density around the abutment tooth of RPDs in patents of different Kennedy classification.

Materials and Methods

Fifty subjects wearing RPD participated in the study (32 women, 18 men). Age mean was 62.1 years (women 61.4, men 63.4). The Kennedy class I was diagnosed in 54% of cases and Kennedy class II in 24% of the analysed sample. Kennedy class III was present in 18% of patients wearing RPD and Kennedy class IV in only 4%. The patients wearing RPD were chosen randomly at the Dental Department of the School of Medicine, University of Rijeka. Ethical Comittee of the Faculty of Medicine approved the study and all patients signed their informed consent. All the examined teeth were radiographed twice by a standard retroalveolar radiography, the first time prior to receiving their new RPD (radiographs had been obtained for diagnostic purposes) and the second time after wearing RPDs for three months. All radiographs were recorded under same conditions using the same X-ray apparatus »Ei Niš« (Niš, Yugoslavia) with 1st exposure and voltage X-ray apparatus of 70 kV with constant current strenght of 15 mA/s. »Kodak ultraspeed« films (Eastman Rochester, N.Y.) were used. The films were developed in an automatic dark chamber »Durr Dental XR 24 nova« (Germany). A stepwedge (SW) consisting of five steps 0.1–0.5 mm thick were attached onto each film prior to exposure. The SW was placed carefully not to cover the soft or the hard tissues. The developed radiographs were scanned using the »Umax Astra 3450« (Umax Technologies, Inc, USA) scanner with 8-bit resolution and 300 dpi. Seven ROIs were selected around the tooth root, each 10 pixels in size, and the levels of greyness were measured by software »Scion image« (Beta 4.0.2., USA). The positions of the ROIs were as follows:

ROI 1 – 1 mm mesially from the periodontal ligament at the level of the alveolar crest

ROI 2 – 1 mm distally from the periodontal ligament at the level of the alveolar crest

ROI 3 – 1 mm mesially from the periodontal ligament at the level of the apex of the tooth root

ROI 4 – 1 mm distally from the periodontal ligament at the level of the apex of the tooth root

ROI 5 – 1 mm apically from the periodontal ligament at the level of the apex of the tooth root

ROI 6 – 1 mm mesially from the midway between the distances of ROI 1 and ROI 3

ROI 7 – 1 mm distally from the midway between the distances of ROI 2 and ROI 4.

Figure 1 explains ROIs position.

In case of multi-rooted tooth, only one root (mesial root) was selected. The same ROIs were selected on the both radiographs. The measured grey levels were transformed into equivalents of the copper SW using the polynomials of the 3. degree, according to Knezović-Zlatarić[28]. The difference between the two radiographs was calculated using the SW equivalents in each of the Kennedy classification.

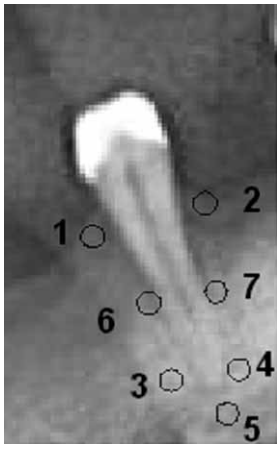

Fig. 1. Position of ROIs.

Statistical analysis

Data were analysed using the Statistical Package for Social Sciences (SPSS Inc, 10.0.1., Chicago, IL). The level of reliability was set at 0.05. One-way analysis of variance was chosen for comparasion of 4 different Kennedy classification.

Results

The level of reliability was checked by coefficient variability. The results were found to have normal distribution ($SD/x<0.44$).The results indicated no statistically significant difference of alveolar bone density changes for any of the selected ROIs during the three month period of RPD wearing between different Kennedy classification (Table 1, Figure 2) ($p>0.05$). No statistically significant difference of alveolar bone density was found in different Kennedy Classes.

TABLE 1
CHANGES OF ALVEOLAR BONE DENSITY DEPENDING ON KENNEDY CLASSIFICATION

Difference	ROI	ROI A	Sum of squares	df	F	p
ROI 1-1A	0.1947	0.1852	0.104	49	1.531	0.219
ROI 2-2A	0.1554	0.1499	0.151	49	0.822	0.488
ROI 3-3A	0.1380	0.1293	0.171	49	0.843	0.477
ROI 4-4A	0.1915	0.1749	0.385	49	0.053	0.984
ROI 5-5A	0.1486	0.1443	0.363	49	0.919	0.439
ROI 6-6A	0.1771	0.1717	0.374	49	0.188	0.904
ROI 7-7A	0.1431	0.1420	0.385	49	0.205	0.892

ROI – region of interest
ROI A – region of interest on the second picture

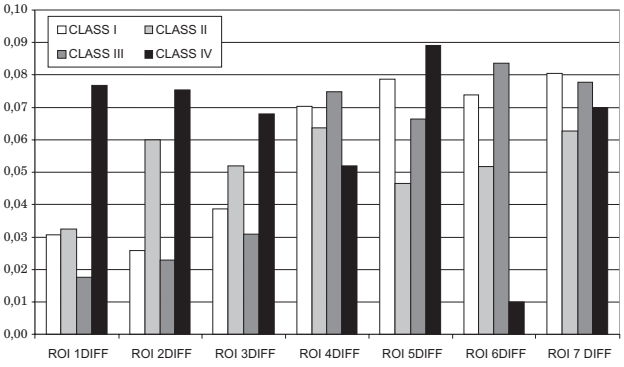

Fig. 2. Changes of alveolar bone density (expressed in equivalents of Cu stepwedge) depending on Kennedy classification.

Discussion

The resorption of alveolar bone around the RPD abutment teeth is a complex process depending on many factors. Retroalveolar radiograph is one of the most simple, low-cost and non-invasive methods to evaluate bone quality. Since the loss of alveolar bone can be visually noticed only when it exceeds the 30% between the 2 different radiographs, it was decided to use calibrated stepwedge[29,30]. The ROI grey level changes (converted into SW equivalents) are percetable when bone loss (reduction of bone density) exceedes 10%[31]. In this study copper SW was used due to copper's atomic number in order to assure thin layers (steps)[32,33]. Too thick calibrated steps is not possible to apply due to a small size of retroalveolar radiographs. The method described by Knezović-Zlatarić method[28] was used, as it was proved to be the accurate method. The literature data suggest that the posterior extensions RPD saddles (Kennedy classes I or II) exert greater loadings to booth, the alveolar ridge and the abutment tooth compared to Kennedy classes III and IV. The RPD also acts as a lever, wich may overload the abutment tooth. Therefore a decrease of bone density can be expected in Kennedy classes I or II. The results of the present study did not prove the hypothesis. There was no statistically significant difference of alveolar bone density around the abutment tooth considering Kennedy classification. This can be explained by an intermitent activity of masticatory forces and a well planned construction of the RPD, i.e. enlargement of the prosthesis base. The masticatory forces are transfered to the abutment tooth via occlusal rests only during the mastication, mostly in axial direction. Imaia and Sato[34,35] studied the influence of constant pressure on changes of alveolar bone density on experimental rat model. The constant pressure is not phisiological and can lead to circulation disturbances, damaging of periodontal apparatus of the tooth and to the bone resorption.

Our RPD design was well planned according to the accepted rules, moreover distal saddles have been extended as much as possible. The masticatory forces are thus distributed on a wide surface and remain within the limits of tissue tolerance, what was in accordance with findings of Tallgren[36]. However, we found a positive trend in the reduction of alveolar bone density in examined ROIs (between first and second radiographs) although there was no statistical siginificance. It can be concluded that RPDs, if well planned, do not cause any significant bone loss in any class of Kennedy classification. Still, a slight reduction of density has been noticed during a three month period. The study included only patients with new RPDs with excellent occlusion, articulation, retention and stability. Over time, the plunge of distally extended saddles is much higher in Kennedy classes I and II than in classes III and IV, so unfavourable loading of the abutment tooth increases with time[37]. Longitudinal measurements should be therefore considered to find possible bone density changes.

Conclusion

During the inital period of RPD wearing (a three--month period) no alveolar bone density changes have been observed depending on Kennedy classification.

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PROMJENE GUSTOĆE ALVEOLARNE KOSTI OKO RETENCIJSKOG ZUBA KOD NOSITELJA DJELOMIČNIH PROTEZA OVISNO O KLASIFIKACIJI PO KENNEDY-U

SAŽETAK

Svrha ove studije bila je utvrditi utjecaj klasifikacije po Kennedy-u (produžena ili umetnuta sedla) na promjeneu gustoće alveolarne kosti oko zuba nosača kvačica i upirača tijekom 3 mjeseca nošenja proteza. U istraživanju je sudjelovalo 50 ispitanika obaju spolova, nositelja djelomičnih proteza (DP). Metodom intraoralne mikrodenzitometrije procijenila se promjena gustoće kosti oko retencijskih zuba. Svi ispitivani zubi su dva puta snimani standardnim retroalveolarnim rendgenskim snimkama u razdoblju od 3 mjeseca. Na svaki rendgenski film nalijepljen je bakreni kalibracijski klin debljine 0,1–0,5 mm. Na svakom rendgenogramu odabrano je 7 područja interesa (eng. region of interest ROI) oko korijena zuba veličine 10 pixela. Izmjereni su nivoi sivila u ROI i pretvoreni u ekvivalent debljine bakrenog klina te je izračunata razlika u gustoći kosti između dvije snimke. Rezultati su pokazali da klasifikacija po Kennedy-u ne dovodi do statistički značajnih promjena gustoće kosti kod protetskih pacijenata tijekom razdoblja od tri mjeseca (ANOVA: $p>0,05$).