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COMPARISON OF MCI - INDEX AND DEXA - TEST ON MENOPAUSAL WOMEN - ITS IMPORTANCE IN EARLY DETECTION OF OSTEOPOROSIS

СПОРЕДБА НА MCI - ИНДЕКС И DEXA - ТЕСТ КАЈ ЖЕНИ ВО МЕНОПАУЗА - НЕГОВАТА ВАЖНОСТ ВО РАНО ОТКРИВАЊЕ НА ОСТЕОПОРОЗА

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Abstract

Osteoporosis is a metabolic bone disease that mostly affects women in menopause, but men too are not excluded. The disease develops in a hidden form without any symptoms and often patients detect the disease only when fractures occur. Early detection of the disease is the objective of many researchers, since access to standard diagnostic methods such as the Dexa test (dual-energy X-ray absorptiometry) is limited in many countries of the world. **Aim:** The objective of this research was to determine the validity of the qualitative indicator MCI – index (Mandibular cortical index) the classification of changes in the structure of the lower cortex of the mandible C1 – C3 in the Panoramic Radiograph and the correlation with the bone mineral density in the L1-L4 vertebral region measured by DEXA – the test. **Material and methods:** Mandibular cortical index vas evaluated visually using orthopantomogram referring to Klemetti method: both sides of the mandibula in the region of foramen mental and compared with body BMD in 60 women, which were then divided in two groups according to T–score values. First group, study group diagnosed with osteoporosis T-score < -2.5 and control group without diagnose with osteoporosis with T-score -1 - 2,5 and T score > 1. Each group was divided in two subgroups according to age difference 50-60 years old and 60-80 years old (mean age of 63,7) to evaluate also the relationship of MCI with age. Results: To determine if there was a significant correlation between MCI and DEXA – test and MCI with age, Fisher's exact test was used. Statistical analysis showed significant correlation of DEXA – test and MCI index p<0.001. Using Pearson Chi-Square test, a significant correlation was found between MCI index and age. Pearson Chi-Square = 60,00 and p<0,001(p=0,00). **Conclusion:** MCI index, as a visual qualitative index, is a valid index to determine the early sign of osteoporosis using panoramic radiography. There is a significant correlation between C2 and C3 MCI - index and DEXA – test. Also, a significant correlation was determined between age and MCI index. Further research in this field is necessary. **Key words:** Klemetti index, osteoporosis, osteopenia, panoramic radiography, mandibular cortical index, major public health problem.

Апстракт

Остеопорозата е метаболичко за болување на коските што најмногу ги погодува жените во менопауза, но не ги исклучува и мажите. Болеста се развива во скриена форма без никакви симптоми и често пациентите ја откриваат болеста само кога ќе се појават фрактури. Раното откривање на болеста е цел на многу истражувачи, бидејќи пристапот до стандардните дијагностички методи како што е тестот DEXA (апсорптиометрија со двојна енергија на X-зраци) е ограничен во многу земји во светот. **Цел:** Целта на ова истражување беше да се утврди валидноста на квалитативниот индикатор MCI – индекс (Mandibular cortical index), класификацијата на структурата на долниот кортекс на мандибулата C1 – C3 во панорамската радиографија и корелацијата со коскената минерална густина во вертебрален регион L1-L4 мерена со DEXA – тестот. **Материјал и методи:** Мандибуларниот кортикален индекс беше визуелно евалуиран со употреба на ортопантомограм кој се однесува на методот Kemetti: двете страни на мандибулата во пределот на форамен ментал и споредени со телесната BMD на лумбалната област L1-L4 со двојна енергетска апсорптиометрија кај 60 жени, кои што беа поделени во две групи според вредностите на T-критериуми. Првата студиска група дијагностицирана со остеопороза T-критериуми -2,5 и контролната група без дијагноза со остеопороза T критериуми 1, -1 - -2,5. Секоја група, студиска и контролна група беа поделени во две подгрупи според возрасната разлика 50-60 години и 60-80 години, за да се оцени и односот на MCI со возраста. **Резултати:** За да се утврди дали постои значајна поврзаност помеѓу MCI и DEXA - тестот и MCI со возраста, се користеше точниот тест на Fisher. Статисичката анализа покажа значајна корелација помеѓу DEXA – тестот и MCI индексот p<0.001. Со користење на Pearson Chi-Square тестот, беше утврдена значајна врска помеѓу индексот MCI и возраста. Pearson Chi-Square = 60,00 и p<0,001(p=0,000) / Monte Carlo Sig. (2-страно). **Заклучок:** Индексот MCI како визуелен квалитативен индекс е валиден индекс за одредување на раниот знак на остеопороза со помош на панорамска радиографија. Постои значајна врска помеѓу MCI -index C2 и C3 и DEXA – тест. Исто така, беше утврдена значајна врска помеѓу возраста и DEXA – тестот и возраста и MCI индексот. Потребни се дополнителни истражувања на ова поле. **Клучни зборови:** Clementi индекс, остеопороза, остеопенија, панорамска радиографија, мандибуларен кортикален индекс, голем јавно здравствен проблем.

Introduction

Osteoporosis is a metabolic bone disease, which results as a consequence of the lack of proper harmonization between the process of formation and resorption of bone tissue. The disease is characterized by microarchitectural weakness, which further results in bone fragility and increased risk of fractures. The disease develops with progress in a latent form, and in most cases, it is diagnosed only when fractures occur[1].

The disease is more common in women as a result of hormonal imbalance, especially in menopause stage above the age of 50. One in three women and one in five men suffer from osteoporosis, and the same is not detected until a fracture occurs. Around 200 million women in the world suffer from osteoporosis, while the resulting fracture occurs every three seconds. Loss of bone mass is related to low estrogen levels during menopause, which is accompanied by gradual loss of trabecular and cortical bone. The largest rate of bone loss occurs in the first 4 - 7 years of menopause to slow down in the following years. Osteopenia is not treated as a pathological condition, but the diagnostic values of osteopenia increase the preventive vigilance, which is one of the fundamental goals in the fight against the osteoporosis, which has rightly been declared as the "silent epidemic".

Since it is a latent disease with a high mortality rate, approximately 40% of women with osteoporotic fractures of the spine die five years after the first fracture occurs. As a result, osteoporosis is considered a special public health and social problem and constitutes a heavy economic burden for the state as well.

Bone mineral density - BMD represents the amount of bone mass in a given bone volume. DEXA-test is one of the examination methods that is described as the gold standard for the diagnosis of osteoporosis, which evaluates the density of the bones at the level of the vertebrae, femur, forearm and neck.

Based on the WHO criteria, the BMD values are divided in clinical diagnostic guidelines:

Normal T-score > - 1.0, osteopenia T-score between - 1.0 - 2.5 and osteoporosis T-score < -2.5.

According to the WHO criteria, osteoporosis is defined as a BMD of 2.5 standard deviations below the mean peak mass (average of young adults) measured by dual-energy X-ray absorptiometry (DEXA)[2,3,4,5,6].

Since the disease is latent and has serious consequences, access to diagnostics is also limited, this has led researchers to expand the range of research for new forms of examinations for the purpose of detecting the disease in its early stage. Early detection prevents the disease and enables starting the treatment before complications occur.

Numerous studies of the last decade have been focused on researching and highlighting the relationship between body BMD and mandibular BMD using more accessible diagnostic tools. Panoramic radiography is considered a valuable diagnostic tool, given its low cost, small radiation dose and routine use in daily dental practice.

One of the reliable indicators used is the Mandibular Cortical Index - MCI, which was described by Klemetti. MCI describes the degree of porosity of the mandibular cortex. This visual assessment of porosity on both sides of the mandible distal to the mental foramen is used to investigate early signs of osteoporosis[7,8].

The general bone loss that occurs during osteoporosis is characterized by morphological changes in the jawbones. The cortical part of the mandible is conditioned more by the general condition of the bones of the body, while the trabecular part or the remaining ridge is subject to continuous resorptive processes that are influenced also by other factors besides osteoporosis. The morphological changes are characterized by thickness reduction of the lower edge of the mandible, and the porosity of the lower border of the mandible. Evaluation of bone density of the jaws is necessary in the preparatory dental therapeutic procedures.

Horner and Dalvin in their longitudinal studies have found a significant correlation between MCI and BMD of the mandible. Tauchi and colleagues in their studies of 150 Japanese women have concluded that dentists have enough clinical information to refer women for final examinations. Research in Japan has shown that 95% of Japanese women with identified changes in the shape of the mandibular cortex resulted with osteopenia and osteoporosis. Studies by Dutra et al. have highlighted that changes in the mandibular bone are related to loss of overall bone density[8,9,10].

MCI - index or Klemetti's index is a qualitative index that is based on the appearance of the inferior cortex and is classified based on the criteria defined by Klemetti:

- C1 - The endosteal margin of the cortex is sharp and clear on both sides of the mandible.
- C2 - Semi lacunar defects are seen in the endosteal margins (lacunar resorption).
- C3 - The cortical layers form residual remains and it is clearly porous.

The validity of the MCI - index is closely related to the skills of the examiner[10,11,14,17,18].

Aim

The aim of our research was to evaluate the MCI index in panoramic radiography, evaluation of the correlation of MCI with Dexa test values as well as the correlation of the MCI index with age.

Material and methods

The research included 60 women divided into two groups based on DEXA - test values.

Study group, 30 women with T – score < – 2.5 divided into two subgroups with age deference 50-60, 60-80 years old.

Control group, 30 women without diagnose with osteoporosis with T score > -1, T score > - 2,5 divided into two subgroups with age deference 50-60, 60-80 years old.

Each group was divided in two subgroups based on age difference to evaluate the correlation of MCI - index with age.

The criteria for the selection of patients were:

- Women age 50 – 80 years old.
- Total edentulous of the maxilla and mandible, carrier of total prostheses.
- All women were in the natural postmenopausal stage.
- Women who have been under therapy that affects bone metabolism biphosphates, vitamin D minerals, hormonal therapy, where not included in our study.
- Women suffering from systemic diseases that attack bone metabolism (renal insufficiency, hyperparathyroidism, hypoparathyroidism, gastrointestinal diseases, rheumatoid arthritis) were not included in the research.

The patients were examined and the detailed anamnesis was recorded.

The research was approved by the Ethics Committee of the Chamber of Dentists of Kosovo. The general bone density was determined by the Dexa test (Dual-energy – ray absorptiometry) using MEDILINNK, model: MEDIX DR 2020. Each patient further underwent a radiological examination by means of Panoramic Radiography using Sirona - Orthophos E.

The index was visually evaluated twice by one examiner and was classified based on the classification according to Klemetti:

Mandibular Cortical Index – MCI, Klemetti index

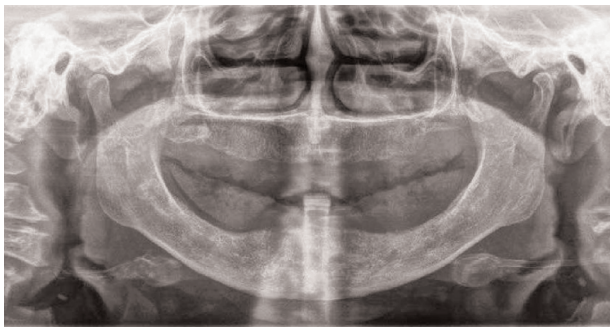


Figure 1. *C1 - Klemetti index: normal where the margins of the cortex are visible and clear*

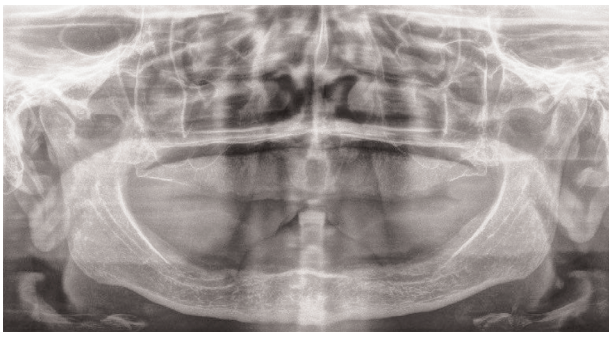


Figure 2. *C2 - Klemetti index: the margins of the cortex show moderate erosion in the form of lacunar resorption*

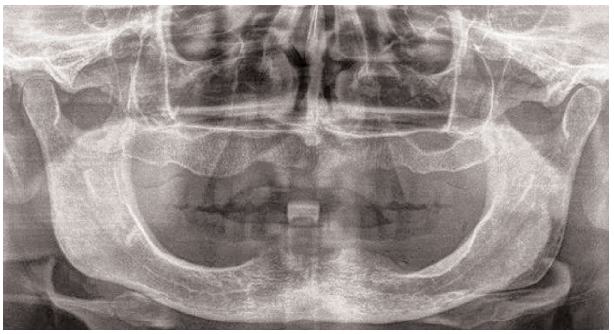


Figure 3. *C3 - Klemetti index: the cortex shows marked erosion with remained highlighted residuals*

Results

30 patients from the study group with DEXA < -2.5, 0 of them had C1- category of MCI index,

21(70%) of them had C-2category of MCI - index, and 9 (30%) of them had C-3 category of MCI index.

10 (47.6%) patients from 30 of them from control group, with T- score > -2,5 had C1 - category of MCI and 11(52,4%) of them had C- 2 category of MCI - index.

A significant association between DEXA - test and MCI index is found for p<0,001.

1. Osteoporosis: T- score < - 2.5, 2. Osteopenia - score >- 2.5, 3. Normal T – score >-1, MCI, C1- normal cortex, C2 - moderate changes of cortex, C-3 - significant changes of mandibular cortex

In patients aged 60-80 years old from study group, we have 34,4% with C2 category, and 44% with C3 category of MCI - index.

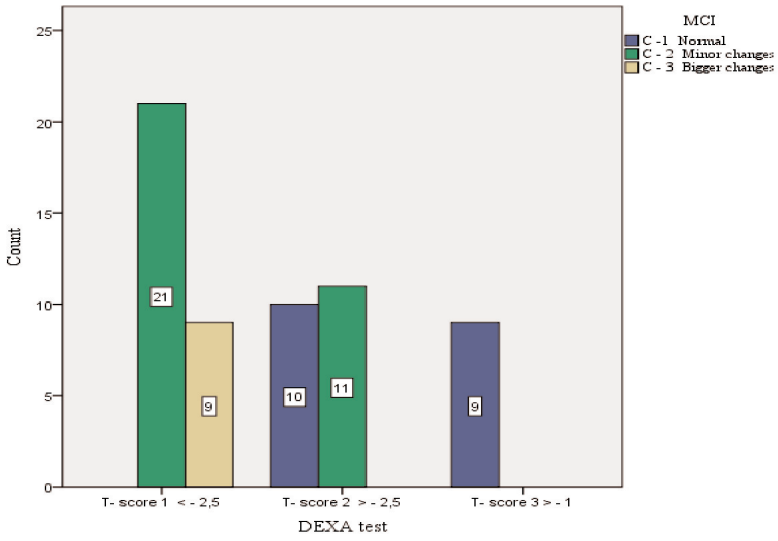
Also in the control group, with increasing age, the category that identifies porosity of mandibular cortex increases: 60-80 years old 6 (31.6%) have C1 and 9 (28,1%) have C2 category of MCI -index, 50 - 59 years old we have (68,4%) with C1 category and 2 (6.3%) with C1 category of MCI index. A significant association between MCI index and age was found for p<0.001.

Table 1. Data of analysis for association between DEXA – test and MCI index

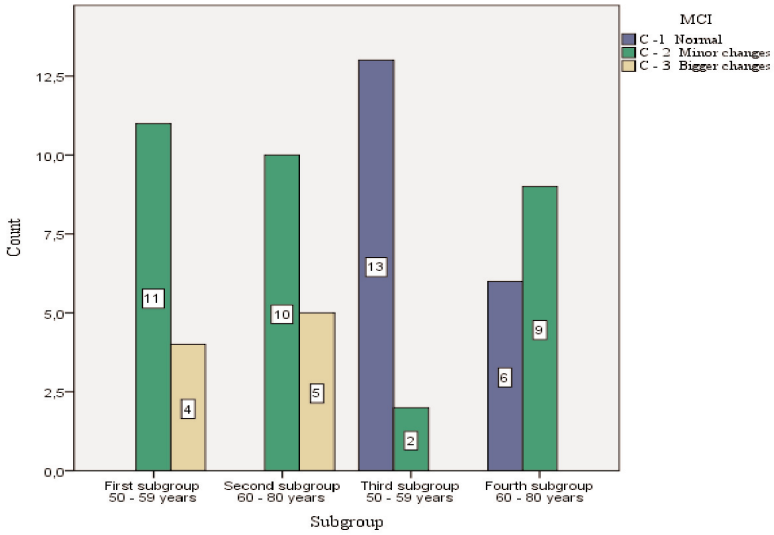
			MCI			Total
			C1 Normal	C2 moderate changes	C 3 very porous cortex	
DEXA test	T – score < - 2,5	Count	0	21	9	30
		%	0,0%	70,0%	30,0%	100.0%
	T – score > - 2,5	Count	10	11	0	21
		%	47,6%	52,4%	0,0%	100.0%
	T – score > - 1	Count	9	0	0	9
		%	100,0%	0,0%	0,0%	100.0%
Total		Count	19	32	9	60
		%	31,7%	53,3%	15,0%	100.0%

Table 2. Data of analysis for correlation between MCI - index and age

Subgroups			MCI			Total
			C1	C2	C 3	
	First 50 - 59 years	Count	0	11	4	15
		%	0,0%	34,4%	44,4%	25,0%
	Second 60 - 80 years	Count	0	10	5	15
		%	0,0%	31,3%	55,6%	25,0%
	Third 50 - 59 years	Count	13	2	0	15
		%	68,4%	6,3%	0,0%	25,0%
	Fourth 60 - 80 years	Count	6	9	0	15
		%	31,6%	28,1%	0,0%	25,0%
Total		Count	19	32	9	60
		%	100.0%	100.0%	100.0%	100.0%



Graph 1. *Data of analysis for association between DEXA – test and MCI index*



Graph 2. *Correlation of MCI - index and age*

First subgroup from study group 50-80 years old, second subgroup from study group 60 - 80 years old. Third subgroup from control group 50 - 60 years old, fourth subgroup from control group 60-80 years old. MCI, C1- normal cortex, C2- moderate changes of cortex, C3 – very porous cortex.

Discussion

Osteoporosis is a progressive metabolic disease that develops in a completely latent form. In most cases, the disease is detected only when fractures occur spontaneously or after an insignificant trauma. Given the high rate of disability and mortality, scientists have opened the way for research on the early identification of signs of osteoporosis.

Bone density is mainly measured by the Dexa test, which also stands out as gold standard. Many countries do not meet the screening standards for osteoporosis required by the WHO (10 DEXA testing machines per 1000 inhabitants) because access to the equipment has a high cost. Therefore, researchers have explored alternative screening methods for early detection of the disease[1,2,3].

Panoramic radiography is considered a valid tool to assess the condition of the mandibular cortex and to measure the radio morphometric indicators, considering that it offers optimal observation of the necessary structures, a clear view of the reference points, is very accessible and low-cost[6]. In this context, our research was developed, giving us grounded data that fulfill other researches.

The Klemetti index is categorized into three levels C1-C3 depending on the changes in the cortex of the mandible. The indicator is visually assessed at the level distal from the mental foramen because this part is considered to be constant and not subject to the influence of other factors. C1, shows the normal mandibular cortex, which is clear and well demarcated C2, shows moderate changes in the mandibular cortex where visible changes are seen in the form of lacunar resorption and C3 where the changes are very visible with pronounced porosity of the mandibular cortex and with remaining deposits. Studies show a direct correlation between reduced T-score values and advanced age. With age the risk of osteoporosis also increases[7,8].

In our study, of 30 patients diagnosed with osteoporosis, 0 of them had MCI - C1 category or normal cortex, 21(70%) of them had C-2 category of MCI - index, and 9 (30%) of them had C-3 category of MCI index.

10 women (47.6%) that weren't diagnosed with osteoporosis with T- score > -2,5 had C1 - category of MCI, or normal mandibular cortex, 11(52,4%) of them had C-2 category of MCI.

Data analysis from our study shows that as the T-score values decreases the degree of porosity of the mandibular cortex increases. We found a significant correlation between osteoporosis and MCI - index with p<0,001.

C2 and C3 - MCI categories increase with age, while category of C1 - MCI index that represents the normal cortex is seen more in subgroups of younger women. Tabela 2, graph 2.

We found a significant correlation between MCI and age with p<0,001.

However, there is still no agreement among researchers on the degree of reliability of MCI indicator in detecting early signs of osteoporosis. Horner and Devlin showed that both MCI and MI (mental index) were significantly correlated with mandibular BMD and body BMD, on the other hand, Gulashi et al. in their

study have not found a relationship between MCI and osteoporosis.

Klemetti found a sensitivity of 71% and specificity of 40% for MCI index. Tauchi et al. found that for normal postmenopausal women with any cortical erosion the sensitivity of MCI is 86.8% and specificity is 63.6%. Healing found that that a negative finding of MCI, CI<2 is a high predictor of the absence of osteoporosis. Marandi found that MCI is a simple three-graded classification of the changes in the cortex with high sensitivity in detecting osteopenia and osteoporotic patients. Cakur et al. also provided the same data from their research[9,10,11,12,13,18].

Conclusion

Mandibular cortical index as a qualitative index can give us very useful data to identify the early signs of osteoporosis. In our study C2 and C3 category of MCI-index have shown a significant relationship with the values of Dexa-test.

We consider that combined with other radio morphometric measurements they can serve as a very important guide to identify the early signs of osteoporosis by dentists.

Dentists, if they trained how to evaluate the MCI index and other radiomorphometric indicators, will be able to identify the early signs of osteoporosis and guide the patients for additional final examinations by specialists.

Reference

1. Anne C. Looker, Ph.D., and Neda Sarafrazi Isfahani, Ph.D., National Center for Health Statistics; and Bo Fan, M.D., and John A. Shepherd, Ph.D., University of California, San Francisco FRAX-based Estimates of 10-year Probability of Hip and Major Osteoporotic Fracture Among Adults Aged 40 and Over: United States, 2013 and 2014
2. Gullberg B, Johnell O. Kanis JA. Worldwide projections for hip fracture. Osteoporosis International, 1997, 7:407–413.
3. Chrischilles E, Shireman T, Wallace R. Cost and health effects of osteoporosis fractures. Bone, 1994, 15:377–386.
4. Cosman F, de Beur SJ, LeBoff MS, Lewiecki EM, Tanner B, Randall S, Lindsay R; National Osteoporosis Foundation. Clinician's Guide to Prevention and Treatment of Osteoporosis. Osteoporos Int. 2014 Oct;25[10]:2359-81. doi: 10.1007/s00198-014-2794-2. Epub 2014 Aug 15. Erratum in: Osteoporos Int. 2015 Jul;26[7]:2045-7. PMID: 25182228; PMCID: PMC4176573.
5. LeBoff MS, Lewiecki EM, Tanner Randall S, et al. Clinician's guide to prevention and treatment of osteoporosis. Osteoporosis Int 2014; 25:2359-81.
6. Yamada S, Uchida K, Iwamoto Y, Sugino N, Yoshinari N, Kagami H, et al. Panoramic radiography measurements, osteoporosis diagnoses and fractures in Japanese men and women. Oral Dis 2015; 21:335-41.
7. Horner K, Devlin H. The relationship between mandibular bone mineral density and panoramic radiographic measurements J Dent 1998; 26:337-43.
8. Anders Halling, G. Rutger Persson, Johan Berglund Owe Johansson, Stefan Revert Comparison between the Klemetti index and heel DXA BMD measurements in the diagnosis of reduced skeletal bone mineral density in the elderly
9. Horner K, Devlin H. The relationships between two indices of mandibular bone quality and bone mineral density measured by dual energy X-rayabsorptiometry.Dentomaxillofac Radiol1998; 27:17-21.
10. Horner K, Devlin H. The relationship between mandibular bone mineral density and panoramic radiographic measurements J Dent 1998; 26:337 43.
11. Dutra V, Devlin H, Susin C, Yang J, Horner K, Fernandes AR. Mandibular morphological changes in low bone mass edentulous females: evaluation of panoramic radiographs. Oral
12. Taguchi A. Triage screening for osteoporosis in dental clinics using panoramic radiographs. Oral Di s. 2010; 16:316–27
13. Zlatarić DK, Celebić A. Clinical bone densitometric evaluation of the mandible in removable denture wearers dependent on the morphology of the mandibular cortex. J Prosthet Dent. 2003; 90:86–91.
14. Lawrence G Rais Pathogenesis of osteoporosis: Concepts, conflicts, and prospects J. Clin Invest 2005 Dec; 115[12]:3318-2
15. Estera Balcikonyte, Irena Balciuniene, Vidmantas Alekna, Baltic Dental and Maxillofacial Journal 6 Panoramic Radiographs in Assessment of the Bone Mineral Density 17- 19, 2004.
16. Srdan D. Postic, Changes in jaw dimensions and Bone Density in patients with osteoporosis, SDJ vol 56, N 1, 2009
17. Klemetti. E Kolmakow S Morfology of the mandibular cortex on panoramix on panoramic radiographs as an indicator of bone quality. Dentomaxillofacial Radiol 1997:26 [1] :22 – 5
18. Cakur B Sahin A, Dagistan S, Altun O caglayn F, Miloglu O, Harorli A dental Panoramic Radiography in the Diagnosis of osteoporosis J Int med Res 2008:36[4]:792-9
19. Postic D. Srdan,Vujasinovi Stupar Nada, Asoti, Mithat,3 Rakocevi} Zoran, Systemic non-malignant osteoporosis and reduction of edentulous alveolar ridges, Sanamed, 2014:9[10;13 – 23
20. E. Calciolari, N. Donos, J.C. Park, A. Petrie, and N. Mardas J Dent Panoramic Measures for Oral Bone Mass in Detecting Osteoporosis A Systematic Review and Meta-Analysis Res. 2015 Mar; 94[3 Suppl]: 17S–27S
21. GroenJ J, Duyvensz F, Halsted JA. Diffuse alveolar atrophy of the jaw [non-inflammatory form of paradental disease] and pre-senile osteoporosis. GerontClin 1960; 2: 68-86.
22. Cakur B, Dagistan S, Sahin A, Harorli A, Yilmaz AB. Reliability of mandibular cortical index and mandibular bone mineral density in the detection of osteoporotic women. Dentomaxillofac Radiol 2009; 38: 255-261
23. Seok Jin Hong1,2, Byoung Eun Yang1,3, Dae Myoung Yoo4, Sung Jae Kim5, Hyo Geun Choi1,4,6 and Soo Hwan Byun1,3 Analysis of the relationship between periodontitis and osteoporosis/ fractures: a cross-sectional study Hong et al. BMC Oral Health [2021] 21:125
24. Arvind Tripathi, MDS Saumyendra V. Singh, MDS Himanshi Aggarwal, MDS Ashutosh Gupta, MDS . Effect of mucostatic and selective pressure impression techniques on residual ridge resorption in individuals with different bone mineral densities: A prospective clinical pilot study Jpd volume 121, issue 1
25. Yukinori Maruo Goro Nishigawa Masao Irie Morihiko Oka Tetsuya Hara Kazuomi Suzuki Shogo Minagi Stress distribution prevents ischemia and bone resorption in residual ridge Arch Oral Biol, 2010 Nov;55[11]:873-8
26. Hrvoje Kršek and Nikša Dulčić Functional Impressions in Complete Denture and Overdenture Treatment Acta Stomatol Croat. 2015 Mar; 49[1]: 45–53.
27. Ivana Savić Pavičin, Matea Sipina, Tomislav Badel, Tomislav Jukić The impact of osteoporosis in women older than 40 years old Acta stomatal Croat. 2013;47[4]:329-335.
28. Jose López-López, Jose-Manuel Álvarez-López, Enrique Jané-Salas, Albert Estrugo-Devesa, Raul Ayu¬so-Montero, Eugenio

Velasco-Ortega, Juan-Jose Segura-Egea Computer-aided system for morphometric mandibular index computation [Using dental panoramic radiographs]

29. D. Prasanna Kumar S. Jayachandran N. Thilagavathy Diagnostic Validity of Orthopantomogram Comparedto Dual Energy X-ray Absorptiometry Scan in Detecting Osteoporosis