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# Investigation of Relation between Abdominal Aortic Calcium Score and Renal Stone via Multislice Computed Tomography

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**Abstract**

**Objective:** The present study aimed to investigate the relation between abdominal aorta calcium score and renal stones (RS) using computed tomography (CT).

**Methods:** This study comprised 352 subjects who underwent CT of urinary system in our clinic. One hundred and seventy-six subjects with RS were assigned to Group 1 and 176 subjects without RS were assigned to Group 2 (control group). The likely relation of calcium score, an indicator of atherosclerosis of abdominal aorta, with renal stone formation and stone volume, which has not been investigated previously, was investigated using multislice CT (MSCT).

**Results:** Age distribution of the study subjects ranged from 19 years to 87 years (mean, 44.3±15.1 years). Of the study subjects, 224 (63.6%) were male and 128 (36.4%) were female. According to Agatston scoring, the mean aortic calcium score was 348.7±665.7 Agatston unit (AU) in Group 1 and 212.2±486.9 AU in Group 2. Stone volume was 38.1±25.7 cubic millimeter (mm3) in Group 1.

**Conclusions:** Independently from RS volume, the frequency of abdominal aortic atherosclerosis was observed to be higher in the some aged patients with urolithiasis than in the normal subjects. The result was significant ($p<0.05$, $p=0.029$).

**Key words:** Multislice Computed Tomography, Urinary Stones, Arteriosclerosis, Calcification

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## Abdominal Aort Kalsiyum Skoru ve Üriner Sistem Taş Oluşumu Arasındaki İlişkinin Çok Kesitli BT ile Araştırılması

**Öz**

**Amaç:** Bu çalışmada, abdominal aort kalsiyum skoru ve üriner sistem taş (UsS) oluşumu arasındaki ilişki bilgisayarlı tomografi ile araştırıldı.

**Yöntemler:** Bu çalışma; kliniğimizde, üriner bilgisarlı tomografsi (CT) çekilmiş 352 kişiyi içermektedir. UsS olan 176 kişi grup 1 ve USS olmayan 176 kişi grup 2 (kontrol grubu) olarak adlandırıldı. Daha önce litaratürlerde bulunmayan, abdominal aortun aterosklerozunu gösteren kalsiyum skoru ile böbrek taşı oluşumu ve taş alanı arasında olası ilişki çok kesitli bilgisayarlı tomografi (MSCT) ile araştırıldı.

**Bulgular:** Çalışmaya katılan tüm bireylerin yaş dağılımı; minimum (min) 19 yıl (y), maksimum (max) 87 yıldır (ortalama ± standart sapma 44.3±15.1 y). Bu kişilerin 224' ü (%63,6) erkek, 128' i (%36,4) kadındır. Agatston skorlamasına göre ortalama koroner kalsiyum skoru; Grup 1' de 348.7 ± 665.7 au iken Grup 2' de 212.2 ± 486.9 au olduğu görüldü. Grup 1' de yer alan bireylerde taş yüzey alanı 38,1±25,7 $mm^2$ (ortalama±standart sapma) olarak tespit edildi.

**Sonuç:** UsS yüzey alanından bağımsız olarak, ürolitiazis bulunan hastalarda abdominal aort ateroskleroz görülme oranının normal bireylere göre yüksek olduğu görüldü. Sonucun istatiksel olarak anlamlı olduğu tespit edildi ($p<0.05$, $p=0.029$).

**Anahtar kelimeler:** Çok Kesitli Bilgisayarlı Tomografi, Uriner Taş, Arteriyoskleroz, Kalsifikasyon.

## INTRODUCTION

The prevalence of urinary system stone disease is approximately 10%-15% in the Western countries and 20%-25% in the Middle Eastern Countries[1]. Although a few theories have been proposed for the etiology of renal stone formation, none of them could completely explain this multifactorial disease[2]. There are strong evidences linking a series of systemic diseases and renal stone formation. In epidemiological studies, nephrolithiasis has been demonstrated to be related with diabetes mellitus, obesity, and arterial hypertension[3-6].

Atherosclerosis is a progressive process that starts years before its consequences become manifest. In a recent study, the prevalence of subclinical atherosclerosis was found to be higher in young adults with renal stone (RS)[7]. Atherosclerosis and cardiovascular diseases are associated with chronic inflammation. Inflammation and oxidative stress play an enhancing role in renal stone formation[8]. In a study, in which carotid artery intima-media wall thickness was monitored for a long period of time, a remarkable increase was observed in the risk of carotid artery atherosclerosis in cases with symptomatic nephrolithiasis[9].

In some studies detecting abdominal aortic calcified plaques by lumbar X-ray, a correlation was determined between aortic calcification and coronary artery calcified plaque formation[10-12].

The present study aimed to investigate the likely relation of calcium score, an indicator of abdominal aortic atherosclerosis, with renal stone formation and stone volume, which has not been previously investigated in the literature, using multislice computed tomography (MSCT).

## METHODS

### Patients

The present study included 352 subjects who underwent computed tomography (CT) of the urinary system in our clinic. The subjects were those without primary hyperparathyroidism, renal tubular acidosis and similar metabolic diseases. Patients' data were retrospectively obtained from the hospital records. Ethics

committee approval was obtained for the study (07.01.2014, 2014/1). All subjects were examined in terms of including cigarette smoking, hypertension, diabetes mellitus, hyperlipidemia, and familial coronary artery disease.

Before CT scanning, height (Human bascule, NAN TARTI Co, Turkey) and weight (TANITA Body Composition Analyzer, TANITA Corporation, Japan) measurements of the subjects were performed and body mass indexes (BMI) were calculated. Subjects with a BMI of <25 kg/m2 were considered to have normal weight, those with a BMI between 25 kg/m2 and <30 kg/m2) were considered overweight, and those with a BMI of ≥30 kg/m2 were considered obese[13].

## Multislice Computed Tomography Image Reconstruction

Non-contrast-enhanced abdominal CT scans (Somatom Sensation 64, Siemens, Forchheim, Germany) with a section thickness of 0.6 mm beginning from the subdiaphragmatic level to the symphysis pubis were acquired. The scan parameters were as follows: a collimation of 64x0.625 mm, a tube voltage of 100-120 mV, and an effective current of 350-780 mA. Stone volume (SV) of all existing renal stones in each case were calculated in cubic millimeter (mm3) using a volume analysis software (Siemens, Leonardo, GERMANY) (Figure 1,2,3,4).

**Figure 1.** Abdominal aorta Agatston scoring table

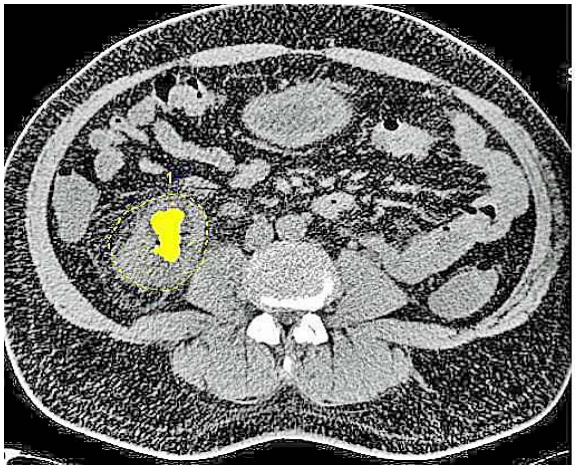


**Figure 2.** Abdominal aorta Agatston scoring table

**Figure 3.** The calculating of renal stone volume was shown

**Figure 4.** The calculating of renal stone volume was shown

## Abdominal Aortic Calcium Scoring

Abdominal aortic calcium scores (AaCs) between the celiac trunk and the iliac bifurcation were calculated in Agatston unit

(AU) (Figure 5,6). Calcium scoring was performed using the existing software in the device (Syngo CaScore, Siemens, Forchheim, Germany, Agatston scoring method)[14]. Extensive calcified plaque formation in the abdominal aorta was shown in figure 7. Left renal stone and calcified plaques in the abdominal aorta was shown in figure 8. Graphical illustration of mean AaCs values according to age in Graphic 1.

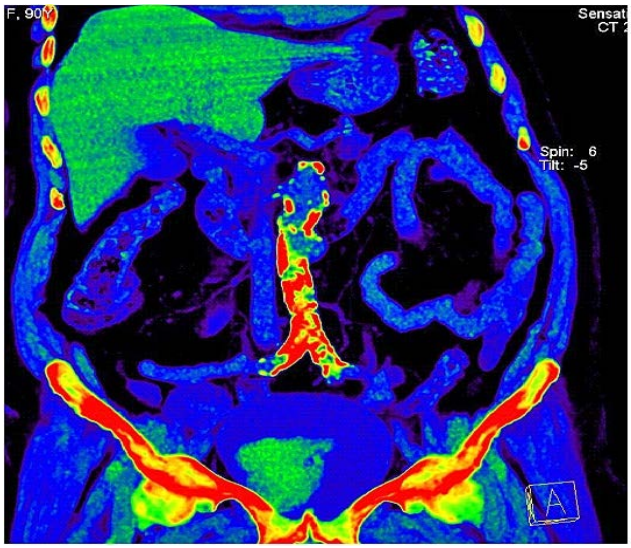



**Figure 5.** The calculating of renal stone volume was shown

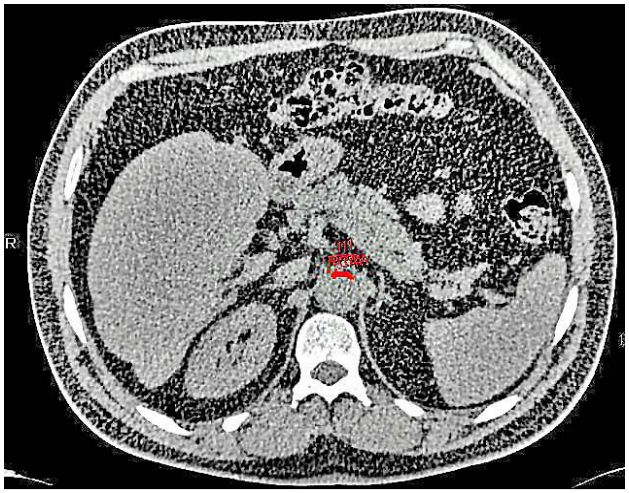
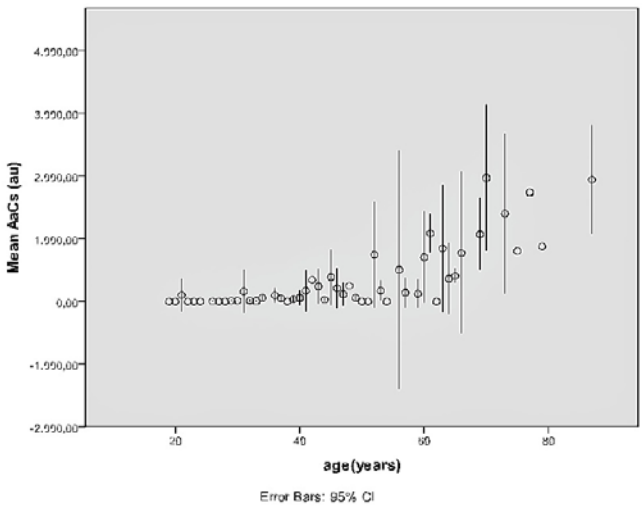


**Figure 6.** The calculating of renal stone volume was shown


**Figure 7.** Extensive calcified plaque formation in the abdominal aorta

**Figure 8.** Left renal stone and calcified plaques in the abdominal aorta




**Graphic 1.** Mean AaCs values according to age

## Study Groups

The study included 352 subjects, of whom 176 had RS (Group 1) and 176 had no RS (Group 2, control group). After separating the subjects in each group according to their gender, they were divided into three subgroups according to age as follows: Subgroup A included those aged <40 years, subgroup B included those aged between 40 years and <60 years, and subgroup C included those aged ≥60 years. SV of the subgroups were investigated individually (Table 2).

**Table I:** Datas according to groups

| | Group 1 ( n=176) | Group 2 ( n=176) | p value |
|---|---|---|---|
| Age (±SD) | 44,9 ±15,5 | 43,6±14,7 | 0,430[T] |
| Gender (male) | 112 (63.6%) | 112 (63.6%) | 0 |
| Smoking | 60 (34.1%) | 60 (34.1%) | 0 |
| Familial CAD history | 35 (19.8%) | 19 (10.7%) | 0,018[C] |
| BMI normal<br>over weight<br>obese | 37 (21%)<br>80 (45.5%)<br>59 (33.5%) | 70 (39.8%)<br>58 (33.0%)<br>48 (27.3%) | 0,001[C] |
| Diabetes mellitus (type 2) | 32 (18.8%) | 18(10.2%) | 0,033[C] |
| Dislipidemia | 43 (24.4%) | 26 (14.8%) | 0,022[C] |
| Hypertension | 46 (26.1%) | 29 (16.5%) | 0,027[C] |
| Aortic Calcium Scoring (AaCs) (au) | 348,7±665,7 | 212,2±486,9 | 0,029[T] |
| Stone Volume (SV)($mm^3$) | 228,6±15,2 | 0 | 0[T] |

*T : P value was presented as a result of Student t-test.*

*C : P value was presented as a result of Pearson Chi-square test.*

*BMI: Body Mass Index, SD : Standart deviation.*

**Table II:** Datas about ages according to groups

| | Group 1 ( n=176) | | Grup 2 ( n=176) | |
|---|---|---|---|---|
| | Male | Female | Male | female |
| 40 y(year)> subgroup a | 52 | 25 | 52 | 25 |
| 40y≤ subgroup b <60y | 39 | 23 | 39 | 23 |
| subgroup c≥60 | 21 | 16 | 21 | 16 |
| Total | 112 | 64 | 112 | 64 |
| Mean age (year) | 44,2±15,1 | 46,1±16,3 | 42,5±13,6 | 45,5±16,3 |

## Statistical Analysis

Statistical analyses were performed using the Statistical Package for the Social Sciences (SPSS, Inc., Chicago, IL, USA). Statistical significance of nonparametric data between the groups was analyzed by Pearson's chi-square test. Parametric data were presented as minimum, maximum, and mean±standard deviation; statistical significance of the parametric data between the groups was analyzed by independent student t-test. A two-tailed p value <0.05 was considered statistically significant.

# RESULTS

## Characteristics of the Study Subjects

The mean age of the study subjects was 44.3±15.1 years, (range, 19 to 87 years). Of the subjects, 224 (63.6%) were male and 128 (36.4%) were female. Hypertension (HT) was present in 75 (21.3%) subjects, cigarette smoking was present in 120 (34.1%) subjects, diabetes mellitus was present in 52 (14.8%) subjects, and dyslipidemia was present in 69 (19.6%) subjects. According to BMI, there were 107 (30.4%) normal weight, 138 (39.2%) overweight and 107 (30.4%) obese subjects. The AaCs of the study subjects ranged between 0 AU and 3751 AU (mean, 208.5±586.3 AU).

## Characteristics of the Study Groups

In Group 1, the male subjects (mean age, 44.2±15.1 years) had a mean SV of 265.2±162.6 mm3 and a mean AaCs of 314.1±592.5 AU according to Agatston scoring. Of the male subjects in Group 1, 33 (29.5%) were obese, 41 (36.6%) were smokers, 25 (22.3%) were hypertensive, 29 (25.9%) were dyslipidemic, and 19 (17%) were diabetic.

In Group 1, the female subjects (mean age, 46.1±16.3 years) had a mean SV of 186.9±128.4 mm3, and a mean AaCs of 409.3±778.9 AU according to Agatston scoring. Of the female subjects in Group 1, 26 (40.6%) were obese, 19 (29.7%) were smokers, 21 (32.8%) were

hypertensive, 14 (21.9%) were dyslipidemic, and 13 (20.3%) were diabetic.

In Group 2, the male subjects (mean age, 42.5±13.6 years) had a mean AaCs of 210.6±526.2 AU according to Agatston scoring. Of the male subjects in Group 2, 26 (23.2%) were obese, 45 (40.2%) were smokers, 13 (11.6%) were hypertensive, 14 (12.5%) were dyslipidemic, and 15 (13.4%) were diabetic.

In Group 2, the female subjects (mean age, 45.5±16.3 years) had a mean AaCs of 215.1±413.1 AU according to Agatston scoring. Of the female subjects in Group 2, 22 (34.4%) were obese, 15 (23.4%) were smokers, 16 (25%) were hypertensive, 12 (18.8%) were dyslipidemic, and 5 (7.8%) were diabetic.

After separating the subjects in each group according to their gender, they were divided into three subgroups according to age as follows: Subgroup A included those aged <40 years, subgroup B included those aged between 40 years and <60 years, and subgroup C included those aged ≥60 years (Table 2). In Group 1, the mean SV was 249.6±164.4 mm3 in subgroup A, 212.4±103.8 mm3 in subgroup B, and 213.0±196.2 mm3 in subgroup C.

Stone SV was found to be 228,6±154,2 mm3 in Group 1. While AaCs was 343.2±657.6 AU in the subjects with a stone SV of ≥ 228,6 mm3, it was 351.3±672.3 AU in the subjects with a SV of lower than < 228,6 mm3. No relation was determined between high stone SV and increased AaCs and no significant difference was found between the subjects with SV higher and lower than the average in terms of mean AaCs (p=0.940 and p>0.05).

subgroup A, 264.51±567.73 in subgroup B, and 868.35± 776.42 AU in subgroup C respectively. The corresponding scores were 30.37±86.19, 62.03± 193.05, and 852.51± 874.27 AU respectively in control group. AaCs in subgroup B with stone disease was significantly higher than the control group(p<0,05). Similary, a significant difference (p<0,05) was also detected for female patients in subgroup C who had stone disease with regard to control group (AaCs for females with Stone disease in subgroup C and control were 996.06±573.23 vs 749.36 ±548.57 AU respectively).

Analyses of the groups in terms of hypertension, diabetes mellitus, dyslipidemia, familial history of coronary artery disease and BMI are demonstrated in Table 1.

## DISCUSSION

In the present study, AaCs, which is considered as an indicator of atherosclerosis, was measured in subjects with and without RS on MSCT scans. The relation between stone SV and AaCs, which has not been previously assessed in the literature, was investigated. It was determined that the frequency of abdominal aortic atherosclerosis was higher in the patients with nephrolithiasis as compared to the normal subjects, independently from SV.

Arterial calcification occurs in the late stage of atherosclerosis and large aortic calcified plaques can be detected on lateral lumbar radiographs. In the present study, abdominal aortic plaques larger than 1 mm and RS larger than 20 mm3 could be detected.

Relation between renal stone formation and obesity has been demonstrated in large epidemiological studies[6,15]. In the present study, 79% of the patients with UsS were overweight or obese.

The risk relation between Type 2 diabetes mellitus and nephrolithiasis is bidirectional[16]. There are studies expressing that UsS formation is enhanced in Type 2 diabetic patients as well as studies demonstrating that the risk of thiazide-induced diabetes is enhanced in those with UsS[17-19]. In the present study, whilst the frequency of nephrolithiasis was 49.6% in the patients without type 2 diabetes mellitus, it was 64% in Type 2 diabetic patients.

In the present study, in Group 1, AaCs was significantly higher in males aged between 40 years and <60 years in Group 1 than in the subjects with same characteristics in the control group (264.51± 567.73 AU vs. 62.03± 193.05 AU, respectively; $p<0.05$). AaCs was also significantly higher in females aged ≥60 years in Group 1 than in the subjects with same characteristics in the control group (996.06 ±573.23 AU vs. 749.36 ±548.57 AU, respectively; $p<0.05$). However, no significant relation was determined between stone size and aortic atherosclerosis. Altered sex hormone composition after menopause might be responsible for the significant relation between urolithiasis and atherosclerosis after the age of 60 years in females. Hormonal change after menopause can cause osteoporosis by decreasing bone formation and increasing bone destruction[20]. Osteoporosis enhances the risk of urolithiasis and atherosclerosis[21,22]. Hypercholesterolemia is a common condition in our population and high cholesterol is a risk factor for urolithiasis and atherosclerosis[23]. Hypercholesterolemia might be one of the causes of high aortic atherosclerosis found in the males aged ≥40 years and <60 years in the stone group.

In some studies, in which abdominal aortic calcified plaques were detected on lumbar X-ray, a correlation was determined between aortic calcification and coronary artery calcified plaque formation[10-12]. Therefore, optimal detection of abdominal aortic calcification is of importance also for cardiovascular diseases.

Karakan et all., mentioned about that comparison between MSCT and chemical analysis angle of stone components, founded that there is nsistence was very low (24).

In conclusion, based on the findings of the present study, it can be suggested that the risk of atherosclerosis is high in some age groups in patients with urolithiasis than in normal subjects, independently from stone size. We are in the opinion that informing the subjects with urolithiasis about cardiovascular diseases might be beneficial. We believe that our results are necessary to be verified in larger-scale studies.

## Study Limitations

In the present study, the number of subjects, who were those undergoing CT scanning with the pre-diagnosis of urolithiasis, was limited. Therefore, larger epidemiological studies are needed to verify the results of present study. In addition, all of the cases were Caucasians from the same geographical region and thus do not represent other ethnic groups or different geographic regions.

## Abbreviations

MSCT: Multislice Computed Tomography

AU: Agatston unit

RS: Renal Stone

BMI: Body Mass Index

SV: Stone volume

mm3: Cubic millimeter

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**Ethics Committee Approval:** Ethics committee approval was obtained for the study (07.01.2014, 2014/1).

**Conflict of Interest:** The authors declared no conflicts of interest.

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