World Journal of Physical and Rehabilitation Medicine

Research Article
Published: 29 Nov, 2022

Association between Abdominal Aorta and Internal and Common Iliac Arteries Calcification with Symptoms of Lower Urinary Tract Syndrome

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Abstract

Background: The relationship between metabolic parameters as well as the activity of atherosclerotic and inflammatory processes with the incidence of Lower Urinary Tract Syndrome (LUTS) in the context of Benign Prostate Hyperplasia (BPH) has been extensively studied. The present study aimed to determine the association between abdominal aortic and internal and common iliac arteries calcification with symptoms of LUTS in patients with BPH.

Methods: This study was conducted on 75 male patients aged higher than 40 years with suspected LUTS/BPH referred to Modarres Hospital in Tehran in 2019 who underwent non-contrasted abdominopelvic CT scan. The International Prostate Symptom Score (IPSS) form was completed by the patients. The severity of LUTS progression was also classified as none, mild, moderate, and severe based on the IPSS score.

Results: Considering IPSS >7 as a diagnosis of LUTS, 62.7% of people had LUTS. We revealed significant positive correlation between IPSS score and calcification score in all studied arteries. According to the ROC curve analyses, calcification scores of all studied arteries could powerfully discriminate mild from moderate to severe LUTS (with AUC ranged 0.808 to 0.870) with high sensitivity (ranged 82.2% to 95.7%) and specificity (ranged 69.2% to 80.0%). The mean transverse size of prostate was 47.88 ± 10.54 mm that was strongly correlated with calcification score in all studied arteries.

Conclusion: There is a direct relationship of the severity of LUTS/BPH and prostate transverse diameter with calcification score in abdominal aorta, common iliac, and internal iliac arteries.

Keywords: Abdominal aorta calcification score; Internal iliac calcification; Common iliac calcification; BPH; LUTS

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Received Date: *07 Nov 2022*
Accepted Date: *23 Nov 2022*
Published Date: *29 Nov 2022*

Citation:
Besharat S, Karami S, Akhoundi N. Association between Abdominal Aorta and Internal and Common Iliac Arteries Calcification with Symptoms of Lower Urinary Tract Syndrome. World J Phys Rehabil Med. 2022; 6(1): 1023.

Introduction

The European Urological Association as well as the American Society of Urologists defined Lower Urinary Tract Syndrome (LUTS) based on stored urine symptoms (including daily urine frequency, emergency urine and nocturnal urine), urinary symptoms (poor or intermittent urinary pressure and flow with incomplete bladder emptying) or symptoms present after dribbling [1,2]. The root cause of such an event remains unclear, but it has been found that Benign Prostate Hyperplasia (BPH) development at first glance mainly results in LUTS. Recently, metabolic syndrome has been identified also as an important factor in the pathophysiology of LUTS/BPH disease [3]. Key factors for metabolic syndrome include abdominal fat-induced obesity, dyslipidemia, hypertension, and insulin resistance associated with secondary hyperinsulinemia [4]. The pathophysiological states of the metabolic syndrome are central to the activity of the sympathetic nervous system and possibly to the increased risk of arterial atherosclerosis [5]. It seems that increased sympathetic nervous system activity may play a major role in the development of LUTS/BPH [6]. Metabolic syndrome may stimulate systemic vascular factors, thereby disrupting the lower urinary tract, resulting in LUTS initiation and lower urinary tract dysfunction [7]. As Ponholzer et al. [8] have shown there is a significant relationship between the onset of LUTS and the four cardiovascular risk factors in both sexes. Recent studies have also shown an important role for bladder ischemia and bladder blood flow change in the expansion and exacerbation of LUTS. Recent animal studies have shown that arterial obstructive diseases, such as vascular atherosclerosis, impair the function of the lower urinary tract by causing bladder ischemia, hypoxia, and activation of oxidative stress in the bladder

[9-12]. These reports all indicate the possibility that atherosclerosis itself has a central pathophysiological role in the development and spread of LUTS in men. Although the relationship between vascular risk factors and LUTS has also been confirmed, the direct effects of atherosclerosis on the function of the lower urinary tract remain a major question. In some preliminary studies, the relationship between visceral fat area and the incidence of LUTS has been demonstrated in patients with BPH [13]. In another study, the relationship between peripheral vascular calcification as well as the aorta with dysfunction of the urinary system arteries has been shown to be a reason for the association between vascular calcification with urinary dysfunction as well as the occurrence of LUTS/BPH. However, these cases are currently under hypothesis and under test [14]. The present study aimed to determine the association between abdominal aorta and internal and common iliac arteries calcification with symptoms of LUTS in patients suspected for BPH.

Methods and Materials

This observational analytic cross-sectional study was conducted on male patients aged higher than 40 years referred to Modarres Hospital in Tehran in 2019 who underwent non-contrasted abdominopelvic CT scan for evaluating abdominal pathologies including abdominal pain, urinary system stones/infections, intra-abdominal malignancies (diagnosis and follow-up), and abdominal trauma. Also, exclusion criteria would be the history of recent anti-inflammatory or corticosteroid or BPH medications and previous abdominopelvic vascular surgeries. Initial patient information was extracted through a review of the patient hospital archived files. All subjects underwent routine evaluation and examination of urinary quality and quantity and other problems of the lower urinary tract. Also, for evaluation of ACI and ICI indices, prostate transverse size of all patients were evaluated with abdominal and pelvic CT. The International Prostate Symptom Score (IPSS) form was also completed by the patients. This form is an eight-question written screening tool used to screen for, rapidly diagnose, track the symptoms of, and suggest management of the symptoms of BPH. The severity of LUTS progression was also classified as none, mild, moderate, and severe based on the IPSS score.

After obtaining written informed consent, all participants underwent abdominopelvic non-contrast Computed Tomography (CT) scan. CT scan was performed using a 64-slice multi-slice CT scanner (Brilliance TM 64; Philips Medical Systems, Bost, the Netherlands) with a slice thickness of 3 mm reconstructed at 1.5 mm intervals, 120 KVP and 121 mAs and collimation 64 × 0.625.

Abdominal aorta and common and internal iliac arteries calcification score were recorded for all patients based on Agatston's method using Heart Beat CS software (Philips, Bost, The Netherlands) from diaphragm to pelvis. The score of every calcification in each vessel for all of the CT slices is reported as abdominal aorta and common and internal iliac arteries calcification score and is then summed up to give the total calcification score [15].

The largest transverse diameter of prostate using axial images was measured by a board-certified experienced radiologist.

For statistical analysis, results were presented as mean ± Standard Deviation (SD) for quantitative variables and were summarized by frequency (percentage) for categorical variables. The association between study parameters was assessed using the Pearson's or Spearman's tests. The value of ACI and ICI parameters to predict LUTS, the area under the ROC analysis was employed. P values of ≤ 0.05 were considered statistically significant. For the statistical analysis, the statistical software SPSS version 23.0 for windows (IBM, Armonk, New York) was used.

For analytic purposes, first the patients were divided into two groups based on Agatston score of zero or higher. Then, age and prostate diameter were compared between these two groups using the independent student *t* test. In the subset of patients with Agatston score >0 (40 patients), Spearman correlation test was applied to determine correlation between Agatston score and age as well as with prostate diameter. The correlation between age and prostate diameter was assessed using Pearson correlation test. Significance level was set at 0.05. The study received ethics approval from the Ethical Committee of Shahid Beheshti University of Medical Sciences and it complies with the statements of the Declaration of Helsinki (#IR. SBMU. RETECH. REC. 1397.596).

Results

In the present study, 75 male patients were included. The mean age of the patients was 60.68 ± 12.85 years, ranging from 40 to 85 years. The mean of the IPSS index was 10.75 ± 6.16. Accordingly, 28 cases (37.3%) had mild LUTS, 38 cases (50.7%) had moderate LUTS and 9 cases (12.0%) had severe LUTS. Considering IPSS >7 as a diagnosis of LUTS, 62.7% of people had LUTS and 37.3% had no disorder. Calcification status in the studied arteries is shown in Table 1. In this regard, the prevalence of calcification in aorta, right common iliac artery, left common iliac artery, right internal iliac artery, and left internal iliac artery was 88.0%, 77.3%, 76.0%, 77.3%, and 69.3% respectively. As indicated in Table 2, we revealed significant positive correlation between IPSS score and calcification score in all arteries

Table 1: Calcification status in the studied arteries.

Variable		Statistics
Aorta	Mean calcification score	1339.57 ± 1583.62
	The prevalence of calcification	66 (88.0)
Right common iliac artery	Mean calcification score	938.00 ± 3452.66
	The prevalence of calcification	58 (77.3)
Left common iliac artery	Mean calcification score	611.49 ± 788.66
	The prevalence of calcification	57 (76.0)
Right internal iliac artery	Mean calcification score	528.37 ± 694.20
	The prevalence of calcification	58 (77.3)
Left internal iliac artery	Mean calcification score	476.06 ± 629.54
	The prevalence of calcification	52 (69.3)

Table 2: Correlation between IPSS and calcification related indices.

Variable		Statistics
Aorta	Mean calcification score	1339.57 ± 1583.62
	The prevalence of calcification	66 (88.0)
Right common iliac artery	Mean calcification score	938.00 ± 3452.66
	The prevalence of calcification	58 (77.3)
Left common iliac artery	Mean calcification score	611.49 ± 788.66
	The prevalence of calcification	57 (76.0)
Right internal iliac artery	Mean calcification score	528.37 ± 694.20
	The prevalence of calcification	58 (77.3)
Left internal iliac artery	Mean calcification score	476.06 ± 629.54
	The prevalence of calcification	52 (69.3)

Table 3: Diagnostic value of arterial calcification indices in predicting LUTS severity.

Artery	AUC	Cutoff point	Sensitivity	Specificity
Aorta	0.87	392.62	91.30%	80.00%
Right common iliac artery	0.868	145.5	95.70%	75.00%
Left common iliac artery	0.826	248.6	84.40%	75.00%
Right internal iliac artery	0.808	238.82	82.20%	69.20%
Left internal iliac artery	0.811	209	83.70%	66.70%

studied. As summarized in Table 3 and according to the ROC curve analyses, calcification scores of all studied arteries could powerfully discriminate mild from moderate to severe LUTS (with AUC ranged 0.808 to 0.870) with high sensitivity (ranged 82.2% to 95.7%) and specificity (ranged 69.2% to 80.0%). The mean transverse size of prostate was 47.88 ± 10.54 mm that was strongly correlated with calcification score in all arteries studied.

Discussion

The relationship between metabolic parameters as well as the activity of atherosclerotic and inflammatory processes with the incidence of LUTS in the context of BPH has been extensively studied. On the other hand, there is also evidence of association between underlying vascular pathologies with the occurrence of urinary tract dysfunction and the occurrence of LUTS. It seems that each of the above parameters can play a central role in predicting the occurrence of LUTS/BPH. The purpose of this study was to investigate the relationship between vascular calcification such as abdominal aorta and iliac arteries to confirm the possibility of predicting the occurrence of LUTS/BPH potentially affecting patients' quality of life through evaluation of vascular calcification indices. What was clearly shown in the present study was that, first, all three indicators of vascular calcification of the abdominal aorta, the common iliac artery, as well as the internal iliac artery, were effectively and potentially capable of predicting the occurrence of LUTS and indeed predicting its severity. All three parameters of the vessels showed the same ability, with high sensitivity and specificity but with different cut-off points. Taken together, these parameters appear to potentially increase their diagnostic and predictive accuracy. On the other hand, given that other risk factors such as cardiovascular risk factors are very effective in predicting LUTS, it seems that a model including these factors in addition to the aforementioned vascular calcification could be able to accurately detect LUTS as well as early estimates provide its intensity. It seems that even before pathological processes in the renal arteries and inferior urinary system can lead to urinary and even genital dysfunction, calcified changes in large vessels such as aorta and iliac may result in the occurrence of LUTS.

In limited studies with a similar goal, this predictive value has been demonstrated for vascular parameters such as vascular calcification. In a similar study by Motoya et al. [13], the aim was to evaluate the effect of abdominal aortic calcification and visceral fat area on the occurrence of LUTS and clinical parameters in patients with BPH. In this study, there was a significant correlation between aortic calcification index with excreted urine volume and also with maximal urinary flow. The visceral fat area was also correlated with the IPSS score [16]. In a study by Han et al. [17], the aim was to investigate the relationship between prostate-related parameters, IPSS index, and urofluorometric parameters and it was shown a significant direct relationship between the IPSS score and the severity of calcification of the periventricular vessels [17]. In the study of Deipolyi et al. [18], the aim was to evaluate the relationship between internal iliac artery occlusion with prostate volume and presence of LUTS or BPH and it was shown that men without iliac artery occlusion had a higher prevalence of LUTS than men with obstruction (27% *vs.* 10%). [18]. Of course, this finding was almost the opposite of the results in the above studies. In Kim et al. [19], study, abdominal aortic calcification was significantly associated with IPSS. However, no relation was found between calcification of iliac arteries with LUTS symptoms, the first confirming and the second contradicting the results of our study. In the study of Yoshinaga et al. [20], by clamping the abdominal aorta, blood flow to the bladder and prostate was reduced. Therefore, it can be concluded that the occurrence of peripheral vascular calcification, especially the abdominal aorta and iliac as the major carriers of the lower vital organs, has led to the progressive obstruction of the lower urinary system, which in turn is associated with the gradual onset of ischemia, resulting in a progressive LUT. It did. On the other hand, the occurrence of calcification itself is associated with inflammatory disorders as well as oxidative stress which can itself lead to physiological abnormalities in peripheral vessels such as inferior urinary system.

Conclusion

As a final conclusion, there is a direct relationship of the severity of LUTS/BPH and prostate transverse diameter with calcification score in abdominal aorta, common iliac, and internal iliac arteries. Therefore, by measuring the rate of calcification of these vessels, it is possible to predict the occurrence of LUTS/BPH and thus improve the quality of life of patients.

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