Nephrolithiasis is associated with an increased prevalence of cardiovascular disease

Fernando Domingos1,2 and Adelaide Serra1,3

1Nephrology Service, Hospital Fernando Fonseca, Amadora, Portugal, 2Faculty of Medicine, University of Lisbon, Lisbon, Portugal and 3Faculty of Medical Sciences, New University of Lisbon, Lisbon, Portugal

Correspondence and offprint requests to: Fernando Domingos; E-mail: fdomingos@netcabo.pt

Abstract

Background. Nephrolithiasis has been associated with hypertension, obesity and diabetes mellitus. The prevalence of adverse cardiovascular outcomes among kidney stone formers (KSF) is unknown.

Methods. We examined the IV Portuguese National Health Survey for documenting possible associations between nephrolithiasis, cardiovascular diseases, diabetes and obesity in the Portuguese adult population.

Results. We obtained 23 349 questionnaires from individuals ≥15 years old. The prevalence of kidney stone disease (KSD) was 7.3%. The prevalence of hypertension was higher among KSF when compared with the general population (50.4 vs 30.2%; P < 0.001). Age and obesity significantly increase the risk for nephrolithiasis. After adjusting for age and body mass index, KSF have higher prevalence of hypertension [odds ratio (OR), 1.841; 95% CI, 1.651–2.053], diabetes mellitus (OR, 1.475; 95% CI, 1.283–1.696; P < 0.001), myocardial infarction (OR, 1.338; 95% CI, 1.003–1.786; P < 0.05) and stroke (OR, 1.330; 95% CI, 1.015–1.743; P < 0.05) compared with non-stone formers.

Conclusions. KSD is associated with a higher prevalence of chronic diseases and adverse cardiovascular outcomes when compared with the general population.

Keywords: cardiovascular risk; diabetes mellitus; hypertension; kidney stone disease; obesity
Nephrolithiasis and cardiovascular disease

Introduction

Nephrolithiasis is a relatively prevalent disease in Western civilizations [1]. Epidemiological studies documented an association of nephrolithiasis with obesity, diabetes mellitus and arterial hypertension [2–5]. These co-morbidities are manifestations of the metabolic syndrome and their high prevalence in kidney stone formers (KSF) points to an involvement of insulin resistance in the pathophysiology of nephrolithiasis [6,7]. Obesity and diabetes promote lithogenesis: uric acid stones are more common in diabetic patients [8] and obesity increases the urinary excretion of promoters of crystallization and urine acidity and contributes to an increase of calcium oxalate lithogenesis [9,10]. An increased risk of kidney stone formation was documented in obese individuals in a large prospective study [11] and in individuals with high fructose consumption [12], a natural sugar implicated in the development of the metabolic syndrome in humans [13]. There is some evidence of an increase of the risk factors for coronary heart disease in KSF [14], but there are no available data to demonstrate that this enhanced risk actually results in adverse clinical outcomes in KSF.

The Portuguese National Health Survey (NHS) is an instrument of analysis with 25 years of experience conducted by the National Health Institute Doctor Ricardo Jorge and the National Institute of Statistics (NIS) of Portugal [15]. This instrument meets the international guidelines of the World Health Organization (WHO) and the EUROSTAT regarding health questionnaires [16,17] and is based on a large probabilistic population sample, randomly selected among residents in Portuguese territory. The fourth NHS allowed us to study possible associations between nephrolithiasis and diabetes mellitus, hypertension, myocardial infarction and stroke.

Materials and methods

The NHS is a validated questionnaire to collect responses for operating 233 variables, according to WHO recommendations for the development of health surveys. The data collection was carried out by direct interview. Interviewers were recruited by the NIS, being preferred not to have training in health sciences to prevent the known effect of focused interviews, and had specific training to conduct the interviews in sensitive areas. A pilot test was done in April 2005, and data collection took place in 2005–06, with a total duration of 52 weeks.

The existence of each chronic disease was coded in a dummy variable, according to the following criteria: a positive answer of the respondents on whether they have or had ever had the disease mentioned, plus a positive response whether that knowledge was transmitted to them by a physician or nurse. The age of onset of the disease and/or diagnosis and the use of drugs or any other form of treatment were also asked. Anthropometric data collected at the time of administering the questionnaires included weight and height. Obesity was defined as body mass index (BMI) ≥ 30 kg/m².

Sample selection

The sample used in the fourth NHS was randomly selected from a mother sample used by the NIS for studies with families among residents in private households from a representative sample of households from the mainland and the autonomous regions of Azores and Madeira, using a system of stratification and systematic selection. The stratification of the mother sample was made at the level of the seven regions defined by the Nomenclature of Territorial Units for Statistics III of the European community. The number of individuals selected within each region was scaled to ensure an equitable distribution across regions, according to the results of the 2001 census and the last NHS held in 1998.

The areas of the interview were selected approximately equally by quarter and week to minimize possible seasonal effects of the survey results. We used the questionnaires of all respondents aged ≥15 years old and whose answers were provided directly to the interviewers; proxy answers were excluded.

Statistical methods

Descriptive statistics were carried out for all variables. Categorical variables were expressed as proportions and compared with the chi-square test. Binary logistic regression was used to analyse the effect of multiple explanatory variables on dichotomous variables. The average of the ordinal variables was compared using Mann–Whitney’s test.

Fig. 1. Distribution of KSF according to age.
Statistical analyses were conducted using SPSS® version 13.0 for Windows (SPSS Inc., USA). A P-value <0.05 was considered significant.

Results

We identified 23,349 surveys who met the inclusion requirements. The prevalence of nephrolithiasis in this population was 7.3%. Compared with individuals without a history of kidney stones, KSF were older (median of the age group, 50–54 vs 60–64 years old; P < 0.001) (Figure 1) and have a slightly higher BMI (26.0 ± 4.5 vs 27.2 ± 4.6 kg/m²; P < 0.001).

The prevalence of hypertension, obesity, diabetes, stroke and myocardial infarction was significantly higher in KSF than in the general population (Table 1).

After correction for age, the odds ratio (OR) for obesity was 29% higher in the population with nephrolithiasis compared with non-stone formers (OR, 1.298; 95% CI, 1.151–1.464; P < 0.001), and the age of onset of hypertension occurred earlier in the first group (49.2 ± 14.4 vs 50.4 ± 14.4 years old; P < 0.05, respectively).

Also, for diabetes, the OR adjusted for age and BMI was higher in KSF compared with non-stone formers (OR, 1.475; 95% CI, 1.283–1.696; P < 0.001). We found no significant association between treatment for kidney stones and the development of diabetes. Only 489 of 1701 KSF reported any kind of treatment for nephrolithiasis, 67 of them were diabetic and 422 were not (P = NS).

After adjustment for age and BMI, the probability of myocardial infarction (OR, 1.338; 95% CI, 1.003–1.786; P < 0.05) and stroke (OR, 1.330; 95% CI, 1.015–1.743; P < 0.05) was increased in KSF compared with non-stone formers. After further adjustment for the concomitant presence of hypertension and diabetes, the association of nephrolithiasis with stroke did not reach significance, and the association of nephrolithiasis with myocardial infarction remained significant only in women (OR, 1.566; 95% CI, 1.001–2.448; P < 0.05).

In individuals who reported kidney stone disease (KSD) and any other of the chronic diseases under study, in most

Table 1. Prevalence of chronic diseases associated with high cardiovascular risk in the studied population

<table>
<thead>
<tr>
<th>Chronic disease</th>
<th>Overall (n = 23,349) (%)</th>
<th>Non-stone formers (n = 21,648) (%)</th>
<th>Stone formers (n = 1,701) (%)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypertension</td>
<td>30.2</td>
<td>28.6</td>
<td>50.4</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Obesity</td>
<td>17.3</td>
<td>16.9</td>
<td>22.7</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Diabetes</td>
<td>10.0</td>
<td>9.4</td>
<td>16.6</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Myocardial infarction</td>
<td>1.9</td>
<td>1.8</td>
<td>3.3</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Stroke</td>
<td>2.3</td>
<td>2.1</td>
<td>3.8</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>
cases, the age at onset of nephrolithiasis preceded the age of development of clinical manifestations of those diseases. The average age difference between the initial manifestations of KSD and the appearance of the other chronic diseases was: hypertension 2.0 ± 15.7 years, P < 0.001; diabetes mellitus 6.5 ± 14.7 years, P < 0.001; stroke 7.8 ± 13.3 years, P < 0.001; myocardial infarction 8.8 ± 17.5 years, P < 0.001 (Figure 2).

Discussion

This study identified significant associations between nephrolithiasis and hypertension, diabetes, myocardial infarction and stroke. Previous studies have documented an increased prevalence and incidence of hypertension in stone formers [18,19] and a higher incidence of nephrolithiasis in hypertensive patients [20,21]. To our knowledge, only one study published in 1973 documented an increased prevalence of coronary heart disease in KSF [22], and that result was not confirmed by others [23]. Our study provides the first independent confirmation of an association between nephrolithiasis and coronary heart disease in a large-scale population and also confirms an increased prevalence of stroke in KSF.

In this study, the associations between nephrolithiasis and hypertension, diabetes or cardiovascular disease (CVD) were only partly justified by the older age and higher BMI of KSF. The relations of hypertension with age and BMI are well documented in older age groups [24] and obese individuals [25]. However, the OR for hypertension in our population with nephrolithiasis remained higher after adjusting the results for age and BMI, suggesting the existence of further risk factors.

Obesity is a known risk factor for diabetes and CVD [26], but in our study, the association of nephrolithiasis with diabetes remains significant after adjustment for age and BMI. It is conceivable that the adverse effects of certain forms of treatment of KSD may result in an increased risk of diabetes and CVD. Thiazide diuretics are frequently used in the treatment of nephrolithiasis, and a possible association between low-dose thiazide diuretics and enhanced risk of diabetes was recently reported by Taylor et al. [27]. An increased risk of diabetes has also been documented in patients undergoing extracorporeal shock wave lithotripsy [28]. However, only a minor proportion of patients in our population had been submitted to any form of treatment for nephrolithiasis, except for symptomatic treatment, and in those who were treated, no association was observed between treatment and the development of diabetes or CVD.

In our study, the age of the diagnosis of nephrolithiasis proceeded the age of the diagnosis of diabetes and other cardiovascular outcomes, in most cases by several years. Even considering that the onset of Type 2 diabetes may precede its clinical diagnosis by as much as 7 years [29], KSD cannot be interpreted as a consequence of diabetes, as usually described in medical literature, but, instead, it appears to occur early in life in individuals with a greater predisposition for the future development of diabetes.

In the past, the search for an association between nephrolithiasis and coronary heart disease gave contradictory results [22,23,30]. Our results document an association between nephrolithiasis and myocardial infarction later in life and, in women, nephrolithiasis remains an independent risk factor after adjustment for the presence of diabetes and hypertension.

Li et al. [31] found a high percentage of cases with a history of kidney stones in patients with normal blood pressure who developed stroke over the 6-year follow-up, but that difference did not reach statistical significance after adjustment for other risk factors. Our study confirms the association between nephrolithiasis and stroke and explains it by the higher prevalence of hypertension and diabetes observed in KSF.

Nephrolithiasis is gradually being recognized as a systemic disease indicative of an adverse metabolic environment [32,33]. The differences in the ages of diagnosis of the different co-morbidities found in our study suggests that the causal mechanism may already be present when the lithogenic process began, and its identification should be part of a more comprehensive intervention in kidney stone prevention.

The results express the need for prospective long-term studies to assess the risk for CVD and diabetes in KSD and it is recommended to undertake a careful assessment of cardiovascular risk factors in stone-forming patients.

Limitations

The recognition of co-morbidities was based on the knowledge that patients have about their own health status and we admit some bias related to the fact that individuals affected by one disease condition may have a greater probability of other conditions being diagnosed, simply by getting more medical attention. The operational definition of nephrolithiasis could not be compared with the concept used by the health professionals who made that diagnosis. It was not possible to identify any biochemical parameters related to nephrolithiasis or cardiovascular risk. The cross-sectional nature of the study did not allow a clear identification of a causal link between nephrolithiasis and the outcomes of interest.

Acknowledgements. The authors want to thank to the Portuguese NSI and the Portuguese National Health Institute Doctor Ricardo Jorge for allowing the analysis of the database of the fourth NHS and specifically to Dr Carlos Dias who is currently responsible for the Portuguese NHS.

Conflict of interest statement. None declared.

References

Serum ratio of soluble triggering receptor expressed on myeloid cells-1 to creatinine is a useful marker of infectious complications in myeloperoxidase-antineutrophil cytoplasmic antibody-associated renal vasculitis

Kouichi Hirayama1, Miho Nagai1, Itaru Ebihara2, Homare Shimohata1, Masaki Kobayashi1 and Akio Koyama3

1Department of Nephrology, Tokyo Medical University Ibaraki Medical Center, Ami, Ibaraki, Japan, 2Department of Nephrology, Mito Saiseikai General Hospital, Mito, Ibaraki, Japan and 3Ibaraki Prefectural University for Health Sciences, Ami, Ibaraki, Japan

Received for publication: 6.3.10; Accepted in revised form: 22.7.10

Abstract

Background. The contribution of infections to the mortality of antineutrophil cytoplasmic antibody (ANCA)-associated vasculitis patients is important and should induce early and careful control of these events. However, the differentiation of infection from active vasculitis is

doi: 10.1093/ndt/gfq506
Advance Access publication 13 August 2010