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Original Article

Physiology Section

Neck Circumference as a Tool for Predicting Hyperuricaemia: A Hospital Based Cross-Sectional Study

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ABSTRACT

Introduction: Upper-body fat distribution has long been recognised as a risk factor to increased cardiovascular disease. Neck circumference has been used as an index for upper body fat distribution. Serum uric acid levels are also included as a risk factor for cardiovascular disease.

Aim: This study was aimed to evaluate the relationship of neck circumference as a parameter in predicting hyperuricaemia.

Materials and Methods: The present cross-sectional study was conducted in the Department of Physiology and Pathology of King George's Medical University, Lucknow, Uttar Pradesh, India, from December 2016 to April 2017. A total of 160 subjects aged 18-60 years were enrolled in the study excluding those having any anatomical deformity, diabetes and/or hypertension for more than five years. Their anthropometric parameters, blood pressure, lipid profile, fasting plasma glucose and uric acid levels were measured.

Results: In this study, 62.5% subjects were males and 37.5% were females. Mean age of the study population was 38.8±13.17 years. The study population was divided into three groups based on their serum uric acid levels. Mean neck circumference of subjects with hyperuricaemia and normal serum uric acid levels were 38.42±2.34 cm and 37.35±3.99 cm respectively and was found significantly higher than subjects with below normal uric acid levels (34.80±4.33 cm). The association of uric acid level with neck circumference was highly significant (p - 0.011).

Conclusion: The significant association of uric acid level with neck circumference suggests neck circumference as an emerging novel marker for metabolic syndrome.

Keywords: Metabolic syndrome, Neck width, Uric acid

INTRODUCTION

The metabolic syndrome is a group of risk factors for Cardiovascular Disease (CVD), including obesity, hypertension, elevated triglycerides and low levels of High-Density Lipoprotein Cholesterol (HDL-C). The clinical manifestations of this syndrome include hypertension, hyperglycaemia, reduced HDL-C, hypertriglyceridemia and abdominal obesity [1].

The prevalence of metabolic syndrome may range from 8 to 13% in men and to 18% in women depending on the population and definitions used [2]. Metabolic syndrome has been recognised as a highly prevalent problem in many countries worldwide [3-5].

It is believed that visceral adiposity lies at the root of the cardio metabolic risk with the consequent syndrome of central obesity/ insulin resistance. Clinical definitions of metabolic syndrome by National Cholesterol Education Program-ATP-III or International Diabetes Federation [6]. have been of enormous value in the diagnosis, management and research on the cluster of metabolic risk factors. Yet, there are evidences that suggest other atherogenic, pro-thrombotic and inflammatory aspects of this syndrome which are not captured by these practical clinical definitions and warrant further investigation, particularly for valuable clinical markers [7].

Although, obesity results in metabolic abnormalities, upper body obesity is more commonly associated with glucose intolerance, hyperinsulinemia, uric calculus, diabetes, hypertriglyceridemia and gout disease than the lower body obesity [1]. Upper body obesity can be assessed by various techniques such as neck circumference, waist circumference, waist-to-hip ratio, waist-to-thigh ratio, sub scapular-to-triceps skin fold ratio and abdominal sagittal diameter [1].

Neck Circumference (NC) has been found to be a simple and time-saving screening measure that could be used to identify overweight and obese individuals. It has been shown that men with NC of less than 37 cm and women with NC of less than 34 cm probably have a less chance of developing metabolic syndrome. The patients above these levels require a more comprehensive evaluation of their status as overweight or obese [8].

Disorders in lipid or glucose metabolism and fasting hyperinsulinemia were found to prevail highest in the highest quintile of NC in a study from Finland [9]. Epidemiological population-based studies on the clinical significance of NC in regard to metabolic syndrome are lacking.

Upper body fat distribution has long been recognised as related to increased cardiovascular disease risk, and neck skin-fold [10] or neck circumference [11]. This has been used as an index for such an adverse risk profile. Objective of this study was to evaluate the relationship of neck circumference as a parameter in predicting hyperuricaemia.

MATERIALS AND METHODS

The present cross-sectional observational study was conducted in the Department of Physiology and Pathology of King George's Medical University (KGMU), Lucknow, Uttar Pradesh, India, from December 2016 to April 2017. Subjects aged 18-60 years who came to sample collection centre of Pathology Department, KGMU, Lucknow for investigations for different ailments were selected as study population.

The formula for sample size calculation is:

$$n = z^2 \{(p(1-p))/e^2\}.$$

where "p" is the sample proportion i.e., prevalence, "e" is the error allowance (at 5% allowance its value is 0.05) and "z" is the constant at a certain confidence level (its value at 90% confidence limit and 80% power is 1.72).

The prevalence of hyperuricaemia in a study [12] was reported to be 19% in men and nearly 5% in women, thus overall prevalence was

nearly 12% (p=0.12) in urban population. Now putting these values into the formula, the equation becomes:

$$n = 1.72^2 \{(0.12*(1-0.12)/(0.05)^2\}.$$

$$= 2.96 * 42.24 = 125.03$$

Thus, the sample size for the problem becomes 125, after adding for a contingency allowance of 30% and rounding off to nearest ten; we get the sample size as 160.

Subjects less than 18 years or more than 60 years of age with any known anatomical deformity which can interfere with anthropometric data, history of diabetes and/or hypertension more than five years were excluded from the study. Ethical clearance was taken from the Ethical Committee of KGMU before the start of the research activity (Registration file number is ECR/262/Inst/UP/2013). The subjects were briefed about the nature of the study and a written informed consent was obtained from each participant on prescribed consent form obtained from research cell. Demographic data like gender and age were collected along with relevant history and findings were recorded.

Weight was measured on portable scale without heavy clothing. The measurement was done after emptying bladder and empty stomach as the blood for biochemical assessment was taken in fasting state. The balance was placed on a hard, flat surface and checked and adjusted for zero-balance before each measurement. The body weight was recorded to the nearest 0.1 kg [Table/Fig-1].

Height was measured by rigid stadiometer to the nearest centimeter while barefoot with minimal clothing so that posture can be clearly seen. Body Mass Index (BMI) was calculated according to formulae, BMI = weight/height^2 expressed in kilogram per meter square. NC was measured to the nearest 0.1 cm just below the laryngeal prominence (adam's apple) perpendicular to the long axis of neck with the subject standing upright and shoulders relaxed using flexible measuring tape [Table/Fig-1] [1].

Blood pressure was recorded in the sitting position after five minutes of rest using LED manometer [Table/Fig-2]. For biochemical analysis, after eight-hour overnight fasting, 5 mL of blood sample of each subject was collected and divided into two parts. One part was collected in fluoride vial containing sodium fluoride-potassium oxalate as an anticoagulant for estimation of fasting plasma glucose [Table/Fig-3]. Second part was collected in plain vial and allowed to clot for half an hour. After half an hour, sample was centrifuged and serum separated for estimation of lipid profile and uric acid level [Table/Fig-3]. The uricase method was used for estimation of serum uric acid.

STATISTICAL ANALYSIS

The data obtained was tabulated on Microsoft Excel spreadsheet. The statistical analysis was done using SPSS (Statistical Package for Social Sciences) Version 15.0 statistical analysis software. The values were represented in number (%) and mean±SD. The ANOVA test was used to compare the within group and between group variances amongst the study groups. Correlation coefficient (r) was used to assess the correlation between NC and components of metabolic syndrome. A probability value (p-value) of less than or equal to 0.050 was considered as statistically significant.

RESULTS

The present study included 160 subjects, out of which 100 were males and 60 were females. Out of 160 subjects, 124 (77.50%) having normal serum uric acid levels were classified as Group I, 20 (12.50%) having serum uric acid below normal levels were classified as Group II and rest 16 (10.00%) had raised serum uric acid levels (above normal) were classified as Group III [Table/Fig-4].

Mean NC of subjects with hyperuricaemia (Group III) and normal serum uric acid levels (Group I) were 38.42±2.34 cm and 37.35±3.99 cm respectively and was found significantly higher than subjects with below normal uric acid levels (Group II) (34.80±4.33 cm). The association of uric acid level with neck circumference was found to be significant (p- 0.011).

Pearson's co-relation showed weak or statistically non-significant co-relation of uric acid with neck circumference (r=0.241). The multivariate equation showed that relationship of neck circumference

Variables	Group I (n=124)		Group II (n=20)		Group III (n=16)		ANOVA	
	Mean	SD	Mean	SD	Mean	SD	F	p- value
Weight (kg)	67.36	14.75	59.02	11.08	69.58	5.98	3.610	0.029
Height (cm)	159.61	9.25	161.40	5.83	165.00	8.42	2.791	0.064
BMI (kg/m^2)	26.54	6.27	22.77	4.56	25.81	4.13	3.511	0.032
NC (cm)	37.35	3.99	34.80	4.33	38.42	2.34	4.643	0.011

[Table/Fig-1]: Association of Uric acid with anthropometric variables

Variables	Group I (n=124)		Group II (n=20)		Group III (n=16)		ANOVA	
	Mean	SD	Mean	SD	Mean	SD	F	p- value
SBP (mmHg)	129.55	15.47	128.40	7.83	123.00	6.93	1.530	0.220
DBP (mmHg)	91.68	10.86	87.20	5.44	83.00	5.37	6.483	0.002
MAP (mmHg)	104.30	11.81	100.93	5.36	96.33	4.42	4.387	0.014

[Table/Fig-2]: Association of Uric acid with hemodynamic variables
(SBP-Systolic Blood Pressure, DBP-Diastolic Blood Pressure, MAP-Mean Arterial pressure).

Variables	Group I (n=124)		Group II (n=20)		Group III (n=16)		ANOVA	
	Mean	SD	Mean	SD	Mean	SD	F	p- value
FBS (mg/dL)	114.51	41.32	141.18	92.72	152.13	54.87	5.405	0.005
S.Chol (mg/dL)	193.90	70.85	158.18	62.23	205.40	34.19	2.866	0.060
S.Tri (mg/dL)	139.28	74.49	139.68	115.56	237.66	111.03	9.748	<0.001
HDL (mg/dL)	56.19	13.86	66.44	6.32	50.28	22.98	6.282	0.002
LDL (mg/dL)	109.87	58.29	116.60	50.61	107.50	15.34	0.157	0.855
VLDL (mg/dL)	27.81	14.81	23.40	14.85	47.50	22.44	12.709	<0.001

[Table/Fig-3]: Association of Uric acid with biochemical variables.
(FBS-Fasting Blood Sugar, S.Chol-Serum Cholestrol, S.Tri-Serum Triglyceraldehyde, HDL-High Density Lipoproteins ,LDL-Low Density Lipoproteins, VLDL- Very Low Density Lipoprotein).

Group	Serum uric acid levels	No. of subjects	Percentage
Group I	Normal levels (3.4-7.2 mg/dL males; 2.4-6.1 mg/dL females)	124	77.50
Group II	Below normal levels	20	12.50
Group III	Above normal levels	16	10.00
	Total	160	

[Table/Fig-4]: Groupwise distribution of study population.

with uric acid was confounded by other variables and did not hold a significant independent estimator role in multivariate scenario.

DISCUSSION

The metabolic syndrome and cardiovascular risk in Asian Indians/ South Asians are heightened by their relative increase in the body fat mass, truncal subcutaneous fat mass, intra-abdominal fat mass, and also by ectopic fat deposition. South Asian Phenotype is characterized by increased waist circumference, increased waist hip ratio and excessive body fat mass [13].

Liang J et al., performed a community-based health examination survey for 6,431 individuals (18-93 y) who were randomly selected from residents living in the urban area of central China, in 2009. The study showed independent association of uric acid with neck circumference (p=0.0001) [14]. Noun B et al., in a study included 561 subjects (231 men and 330 women) who had no known major medical conditions and were not receiving any medication therapy. The subjects were those who attended a family health clinic for any reason between 1998 and 2001. A significant association between neck circumference and uric acid (men, r- 0.50, p- 0.0001; women, r- 0.60, p- 0.001) was found in the study [15].

In a cross-sectional study conducted by Jiang J et al., a total of 8971 subjects were recruited to analyse the association of neck circumference and waist circumference with hyperuricaemia and the association of NC with serum uric acid levels in the non-hyperuricaemia population. The study showed that neck circumference was positively associated with hyperuricaemia in both genders; further, neck circumference was also positively associated with serum uric acid levels in non-hyperuricaemia subjects in both genders [16].

The objective of the present study was to evaluate the relationship of NC as a parameter in predicting hyperuricaemia. The present study showed significant association of NC with uric acid levels. However, significant correlation could not be established between the two parameters (r=0.241); small sample size may be attributed to this.

LIMITATION

The present study's cross-sectional nature limits to some extent its interpretation as to causality of associations. Conclusions reached may not be fully applicable to a population because of the relative small sample size of the present study. Further studies with larger sample sizes and prospective nature are needed to identify the relationship of NC with metabolic syndrome in general population.

CONCLUSION

In this study, majority of the subjects with hyperuricaemia presented with abnormal neck circumference and the association was statistically significant. This suggests that NC may prove to be a novel marker in depicting hyperuricaemia as well as metabolic syndrome in high-risk cases. The studies depicting the relationship between anthropometry, metabolic syndrome and uric acid needs more intensive revisit, as the data are scarce.

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