A Preliminary estimation of baseline urinary hydroxyproline/creatinine levels in a study population of healthy Nigerians

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Abstract

Background: Hydroxyproline is one of the biochemical markers that can be measured objectively as an indicator of normal biological processes or pathological processes. It is usually raised in disease conditions that are associated with bone resorption.

Aim: To determine the urinary hydroxyproline/creatinine levels in a study population of healthy Nigerians.

Methods: This study recruited 22 consenting participants who served as control for another study at the University of Nigeria Teaching Hospital (UNTH) Ituku-Ozalla, Enugu. All participants were required to fast for at least 12 hours overnight and their early morning second void urine collected between 7am and 8am. The collected urine samples were stored frozen at -20°C until analysis. Colorimetric method of analysis of urinary hydroxyproline and creatinine were done using Biovision hydroxyproline kit and Randox creatinine kit respectively. Bivariate analysis was conducted on the collated data using statistical package of social science (SPSS) version 19. The results were recorded as urinary hydroxyproline alone (µg/µL) and as urinary hydroxyproline/creatinine ratio.

Results: The mean urinary hydroxyproline level of 0.020±0.013µg/µL and urinary hydroxyproline/creatinine ratio of 0.016±0.006 were noted for healthy Nigerians.

Conclusions: The urinary hydroxyproline levels in the study population of healthy Nigerians are within normal values reported in other healthy populations.

Introduction

Biochemical markers are useful in management of patients with metabolic bone diseases and monitoring fracture healing.1-2 They provide useful clinical evidence of normal and pathological processes that reflect bone cell activity.3 Changes in their levels are not disease specific rather they reflect changes in bone metabolism and could serve as an alternative to bone histology.4,5

Biomarkers measurements are usually associated with variable techniques and application which typically are non-invasive and can be conveniently measured in urine and blood.6 Urinary measurements of these markers are non-invasive and can be performed at frequent intervals with less risk as compared to other methods of bone assessment such as plain radiographs, histomorphometry, calcium fluxes, densitometric procedures and computer assisted imaging for bones.7 They provide an alternative way of assessing bone cellular activity.8-11

Bone cellular activity involves bone resorption and bone formation in which balance is maintained in health. These activities results in excretion of biochemical markers of which hydroxyproline is a marker of bone resorption. Hydroxyproline is a by-product of post translational hydroxylation of proline within the peptide chain that is released by collagen degradation which is not reused but only catabolised and excreted in urine.12,14 More than half of human collagen comes from the bone with rate of bone turnover being faster than soft tissue thus making excretion of hydroxyproline in urine a good marker of bone resorption.15

Hydroxyproline excreted in urine may be detected either as a free or peptide bound hydroxyproline by colometric or High Performance Liquid Chromatography (HPLC) methods.13,16 Its measurement is the most performed measure of bone resorption and has the longest history of use.10,17,18 Among its uses include monitoring of bone fracture union, metabolic bone diseases such as osteoporosis and in monitoring cancer spread from soft tissue to bone.2,18,19 Searce resources and poor facilities in Nigeria are necessitating the exploration of bone biomarkers such as hydroxyproline as an alternative and cheaper way of monitoring bone disorders. However, normal baseline values in healthy individuals have been reported in literature for different clime but little is known of baseline values in Nigerians. This study was therefore aimed at measuring the normal baseline value of urinary hydroxyproline/creatinine in a study population of healthy Nigerians.
Materials and Methods

Study design
This was a hospital based prospective cross sectional analytical study using consecutive subjects that met the inclusion criteria and served as control for another study.

Study location
Study was conducted at the Oral and Maxillofacial Surgery Department of the University of Nigeria Teaching Hospital (UNTH) Ituku-Ozalla, Enugu. UNTH is one of the tertiary hospitals in the South-Eastern Nigeria with patients from different tribes and religion in Enugu state and neighbouring states such as Anambra, Abia, Ebonyi and Benue.

Inclusion and exclusion criteria
Consenting participants between the ages of 18 years and 40 years were recruited. Patients presented with bone destructive lesions (inflammatory or metabolic) or had fractures of any bone within the last year, as well as other conditions such lactating mothers and postmenopausal women. Patients below 18 years and above 40 years of age or those on steroid therapy/oral contraceptives were excluded.

Participants
Twenty-two healthy participants who served as control for another study were used. They were comprehensively assessed, bio-data and medical history were taken and physical examination was done for each patient after signing the informed consent form and the data was entered into a proforma designed for the study.

Urine collection
Participants were required to fast overnight for at least 12 hours before sample collection. Early morning second urine voided between 7 am and 8 am were collected in a plastic urine bottle without preservative from the participants by the researchers. This provides a reliable data on bone degradation.20 The samples were well labelled and stored frozen in the laboratory in a freezer with thermometer maintained at -20°C till analysis.

Table 1. Mean urinary hydroxyproline of the subjects.

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>Hydroxyproline (µg/uL)</th>
<th>Hydroxyproline/creatinine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>Mean ± SD</td>
<td>Female mean ± SD</td>
</tr>
<tr>
<td>20 - 24</td>
<td>0.02 ± 0.01</td>
<td>0.025 ± 0.017</td>
</tr>
<tr>
<td>25 - 29</td>
<td>0.01 ± 0.01</td>
<td>0.03 ± 0.02</td>
</tr>
<tr>
<td>30 – 34</td>
<td>0.01 ± 0.01</td>
<td>0.01 ± 0.01</td>
</tr>
<tr>
<td>&gt;39</td>
<td>0.02 ± 0.01</td>
<td>0.02 ± 0.01</td>
</tr>
</tbody>
</table>

Table 2. Mean urinary hydroxyproline comparison between male and female of the subjects.

<table>
<thead>
<tr>
<th></th>
<th>Male mean ± SD</th>
<th>Female mean ± SD</th>
<th>t</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydroxyproline (µg/uL)</td>
<td>0.019 ± 0.012</td>
<td>0.025 ± 0.017</td>
<td>0.990</td>
<td>0.334</td>
</tr>
<tr>
<td>Hydroxyproline/creatinine ratio</td>
<td>0.016 ± 0.006</td>
<td>0.017 ± 0.003</td>
<td>0.528</td>
<td>0.604</td>
</tr>
</tbody>
</table>

Table 3. Mean urinary hydroxyproline comparison across the age groups of the male and female subjects.

<table>
<thead>
<tr>
<th></th>
<th>20 - 24</th>
<th>25 - 29</th>
<th>30 – 34</th>
<th>&gt;39</th>
<th>F</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male Hydroxyproline (µg/uL)</td>
<td>0.01 ± 0.01</td>
<td>0.02 ± 0.02</td>
<td>0.01 ± 0.01</td>
<td>0.02 ± 0.01</td>
<td>0.946</td>
<td>0.474</td>
</tr>
<tr>
<td>Male Hydroxyproline/creatinine</td>
<td>0.02 ± 0.01</td>
<td>0.01 ± 0.01</td>
<td>0.01 ± 0.01</td>
<td>0.02 ± 0.03</td>
<td>0.613</td>
<td>0.662</td>
</tr>
<tr>
<td>Female Hydroxyproline (µg/uL)</td>
<td>0.02 ± 0.02</td>
<td>0.03 ± 0.02</td>
<td>0.02 ± 0.02</td>
<td>0.02</td>
<td>0.986</td>
<td>0.469</td>
</tr>
<tr>
<td>Female Hydroxyproline/creatinine</td>
<td>0.02 ± 0.02</td>
<td>0.01 ± 0.01</td>
<td>0.02 ± 0.01</td>
<td>0.03</td>
<td>0.986</td>
<td>0.469</td>
</tr>
</tbody>
</table>

Analysis
The collected stored urine samples were thawed and analyzed for urinary hydroxyproline and urinary creatinine. Hydroxyproline research kit manufactured by Biovision Inc. (Milpitas, CA, USA) was used in the colorimetric analysis of urinary hydroxyproline. They were incubated at room temperature for five minutes. Hundred microliters (µL) of DMAB reagent was then added to each, and the sample were incubated for 90 minutes at 60°C. The plates were read on a micro plate reader at 560 nm. The reading from the standard solution was used to generate linear graph from which sample readings were gotten. The thawed urine samples were also analyzed for urinary creatinine using modified Jaffe’s method as suggested by Bowers21 with creatinine research kit manufactured by Randox Laboratories Limited (Crumlin, County Antrim, United Kingdom). The creatinine of each sample was calculated using the formula: A2- A1 / Std2 - Std1 × Std concentration×50.

Statistical analysis
Data collated was analyzed using Statistical Package for Social Sciences (SPSS) version 19. Bivariate analysis was done, continuous variable were summarized using means and standard deviations while categorical variables were summarized using frequency and percentages. Means of continuous variables were compared using student’s t test and ANOVA. All tests were significant at probability level p<0.05.

Results
Twenty-two urine samples were analyzed for urinary hydroxyproline and the data was entered into a proforma designed for the study.
Hydroxyproline levels and urinary creatinine levels. The results were recorded as urinary hydroxyproline levels alone and urinary hydroxyproline/creatinine ratio. The gender distribution of the subjects was 15 males accounting for 68.2% of the subjects and 7 females accounting for 31.8% of the subjects. The mean ages of subjects were 28.45 ± 6.8 years. Age group of 20-24 years of age accounted for 50.0% of the participants, while the age group of 25-29 and 30-34 years of age accounted for 4.5% and 13.6% respectively. Subjects within age group of 35-39 years and >39 years accounted for 13.7% and 18.2% respectively. Nineteen participants had tertiary education with only 3 participants having secondary education.

A mean value of 0.020 ± 0.013 μg/mL for urinary hydroxyproline and 0.016 ± 0.006 for urinary hydroxyproline/creatinine ratio was noted in the study (Table 1).

The mean urinary hydroxyproline levels for males and females in the study were 0.019 ± 0.012 μg/mL and 0.025 ± 0.017 μg/mL respectively whereas the mean urinary hydroxyproline/creatinine ratio value was 0.016 ± 0.006 for males and 0.017 ± 0.003 for females. There were no significant differences between males and females in the study (p=0.334) for urinary hydroxyproline levels and for urinary hydroxyproline/creatinine ratio, p=0.604 (Table 2).

No significant difference was found between the age groups in mean values of urinary hydroxyproline and urinary hydroxyproline/creatinine ratio values (Table 3).

Discussion

The increased incidence of metabolic and metastatic bone diseases have necessitated renewed interest in bone metabolism biomarkers in recent times. Despite their usefulness in management of bone disease1,17 there are paucity of data in Nigeria especially among Igbos on the baseline values of some of these biomarkers thus necessitating this preliminary study. We noted a mean urinary hydroxyproline/creatinine ratio level of 0.016 ± 0.006 among healthy Nigerians in this study. This mean urinary hydroxyproline/creatinine value was very close to the range reported by Hodgkinson and Thompson, who noted that the normal value for fasting urinary hydroxyproline/creatinine ratio for men and premenopausal women was 0.003-0.015 in their study of 144 healthy hospital workers, aged between 18-59 years, in Leeds, United Kingdom.22 Furthermore, the mean urinary hydroxyproline/creatinine ratio was noted to be 0.016 ± 0.006 for males and 0.017 ± 0.003 for females. This value obtained in our study was close to values reported by George,23 who noted a higher value in males as compared to females. In females, this study observed no significant difference among the age groups; this may be due to the fact that the females in this study were premenopausal. Many studies noted an increase in urinary hydroxyproline/creatinine ratio among females as they age from premenopausal to peri and postmenopausal age.17,23,25 They attributed this increase in urinary hydroxyproline/creatinine ratio to bone loss associated with menopause. This study however, observed a higher value in mean urinary hydroxyproline/creatinine ratio in females as compared to males and this is in contrast to George findings, which noted a higher value in males as compared to females.23 In conclusion, the urinary hydroxyproline levels in the study population of healthy Nigerians are within the normal values reported in other healthy populations. Therefore, 0.016 ± 0.006 for males and 0.017 ± 0.003 for females may serve as a baseline for urinary hydroxyproline/creatinine ratio in healthy young Nigerian adults.

Limitations

The small sample size of the study may have reduced the power of the study. Pre analytical and analytical variability associated with bone metabolism markers measurement such as circadian rhythm and sample processing may also have affected our study. However, further study with larger sample size is recommended.

References

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