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Original Research Article

Proteinuria assessment in preeclampsia: a comparative study

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ABSTRACT

Background: Preeclampsia, a severe pregnancy-related hypertensive disorder, presents substantial maternal and fetal health risks. Accurate proteinuria assessment is crucial but traditional methods are cumbersome and error-prone. This study compares the spot urinary protein/creatinine ratio with 24-hour urine collection for proteinuria estimation in preeclampsia at Kamla Nehru State Hospital for Mother and Child.
Methods: A cross-sectional study with 90 eligible pregnant women collected comprehensive medical data. Both spot urinary protein/creatinine ratios and 24-hour urine collections were analyzed. Strong correlation ($r=0.942$, $p<0.0001$) was observed.
Results: Spot urinary protein/creatinine ratio demonstrated moderate diagnostic accuracy (AUC=0.3). Sensitivity was 100%, specificity 87.9%, with PPV and NPV at 90.4% and 92%, confirming its clinical utility for proteinuria diagnosis.
Conclusions: This study validates the spot urinary protein/creatinine ratio as an efficient method for proteinuria assessment in preeclampsia, with a strong correlation and high diagnostic value. Widespread adoption has the potential to expedite diagnosis, enhance outpatient care, and improve outcomes for preeclampsia patients, addressing a crucial healthcare challenge in maternal and fetal health.

Keywords: Diagnostic accuracy, Maternal and fetal health, Preeclampsia, Proteinuria assessment, Spot urinary protein/creatinine ratio, 24-hour urine collection

INTRODUCTION

Pregnancy, a transformative journey for women, is a time of immense physiological and psychological changes. However, amidst the beauty of this experience, it can be marred by complications, with hypertension during pregnancy being a significant concern. Hypertensive disorders complicate 5 to 10 percent of pregnancies, with preeclampsia standing out as a particularly perilous condition. In both developed and developing nations, hypertensive disorders, including preeclampsia, contribute significantly to maternal morbidity and mortality.[1] Preeclampsia, characterized by high blood pressure and proteinuria (an abnormal increase in protein in the urine), is a multi-system disorder that poses grave risks to both maternal and fetal health. Notably, the presence and severity of proteinuria serve as vital diagnostic criteria and predictors of adverse outcomes in preeclampsia.[2]

Traditionally, the gold standard for quantifying proteinuria has been the cumbersome 24-hour urine collection method. Its limitations, including time consumption and collection errors, necessitate exploration of alternative, more efficient methods. Among these, the spot urinary protein/creatinine ratio during pregnancy has garnered attention for its potential to swiftly identify significant proteinuria, thereby streamlining outpatient care for women with suspected preeclampsia.[3]

However, despite its promise, the clinical significance of this method remains understudied in certain healthcare settings, including at Kamla Nehru State Hospital for Mother and Child. This underscores the importance of rigorous evaluation to determine its efficacy in this context.[4]

This study aims to address this knowledge gap by comparing the protein/creatinine ratio in a single voided urine sample with the traditional 24-hour urine protein collection method for estimating proteinuria in preeclampsia. By doing so, we intend to not only enhance diagnostic accuracy but also improve the clinical management of pregnant women affected by this complex condition.[5]

In the following sections, we will present the methodology, results, discussion, and conclusions of this comparative study. Through empirical evidence and robust analysis, we seek to contribute valuable insights to the field of obstetrics and maternal healthcare. Our ultimate goal is to improve the care and outcomes of expectant mothers grappling with the formidable challenge of preeclampsia.[6]

This study aimed to evaluate the clinical utility of the spot urinary protein/creatinine ratio as a diagnostic tool for proteinuria in preeclampsia, comparing it to the conventional 24-hour urine protein collection method. By assessing the correlation, diagnostic accuracy, sensitivity, specificity, and predictive values of the spot urinary protein/creatinine ratio, we seek to determine its effectiveness in providing a swift and reliable assessment of proteinuria in pregnant women with preeclampsia. The ultimate goal is to contribute empirical evidence that can enhance diagnostic precision, expedite clinical decision-making, and improve the overall management and outcomes of preeclampsia in the context of Kamla Nehru State Hospital for Mother and Child.

METHODS

Study type and place

This study, conducted at Kamla Nehru State Hospital for Mother and Child, took place from September 2014 to October 2015. It employed a cross-sectional design to assess proteinuria assessment methods in pregnant women with preeclampsia. Ethical approval for this study was obtained from the appropriate institutional review board or ethics committee, ensuring that the research adhered to ethical guidelines and protected the rights and well-being of the study participants.

Inclusion criteria

Inclusion criteria comprised women aged 18 to 40 years with a gestational age exceeding 20 weeks, calculated based on the first day of the last menstrual period or 1st-trimester ultrasonography. Participants were required to have a diagnosis of blood pressure (BP) equal to or greater than 140/90 mmHg on at least two separate occasions, measured with an appropriately sized cuff in the seated position, with a minimum 4-hour interval between measurements and with Korotkoff phase V for diastolic blood pressure. Additionally, the presence of proteinuria was necessary for inclusion.

Exclusion criteria

Exclusion criteria encompassed individuals with a history of chronic hypertension and proteinuria before conception or hypertension development before 20 weeks of gestation. Patients with known chronic renal disease, those with a history of recurrent urinary tract infections, and individuals requiring delivery before completing the 24-hour urine sample collection were also excluded.

Procedure

Participants provided informed consent, and their medical history was meticulously recorded, including symptoms of preeclampsia. Anthropometric data and comprehensive physical examinations were conducted. Pregnancy and hypertension tests were performed. Participants collected 24-hour urine samples, and a single voided urine sample was obtained for the spot urinary protein/creatinine ratio.

Urine protein and creatinine levels were measured using spectrophotometry, and the ratio was calculated utilizing an automated spectrophotometry analyzer. This comprehensive approach ensured precise data collection for comparing proteinuria assessment methods.

Statistical analysis

Statistical analysis was performed to evaluate the diagnostic accuracy of the spot urinary protein/creatinine ratio compared to the 24-hour urine protein collection method. This analysis included sensitivity, specificity, predictive values, receiver operating characteristic (ROC) curve analysis, and correlation coefficients. Statistical software, such as SPSS, was used for these analyses to derive meaningful and reliable results.

RESULTS

Demographic distribution

Demographic and clinical characteristics (Table 1) summarizes demographic and clinical characteristics of the study population (n=90) during the period from July 2018 to June 2019. Majority were multigravida (65.55%), with a mean age of 28.9 years and mean gestational age of 31.1 weeks. Blood pressure, platelet count, renal function, and proteinuria parameters were assessed, with diagnostic tests showing high sensitivity (100%) and specificity (87.9%) for identifying pre-eclampsia. The optimal threshold for proteinuria was determined as 0.30.

Table 1: Demographic distribution.

Category	Data
Total study population	90
Study period	July 2018 to June 2019
Inclusion criteria	- Age: 18 to 40 years - Gestation age >20 weeks - Diagnosis of hypertension (BP≥140/90 mmHg) with proteinuria
Exclusion criteria	- History of chronic hypertension - Known chronic renal disease - History of recurrent urinary tract infection - Patients requiring delivery before 24-hour urine sample completion
Sociodemographic information	- Majority were multigravida (65.55%) - Primigravida (45.55%) - Multigravida (65.55%)
Mean age	28.9±5 years
Mean gestational age	31.1 weeks
Blood pressure (mmHg)	- Mean systolic: 146.89±11.61 mmHg - Mean diastolic: 94.98±8.54 mmHg
Platelet count	- <1,00,000 /mm³: 7.77% - > 1,00,000/mm³: 83.88%
Renal Function (mg/dl)	- Mean blood urea nitrogen: 11.21±3.7 mg/dl - Mean serum creatinine: 0.82±0.6 mg/dl
Proteinuria evaluation	- Urine protein creatinine ratio (mean): 1.74±2.32 - Optimal threshold for proteinuria: 0.30
Sensitivity and Specificity	- Sensitivity: 100% - Specificity: 87.9% - Positive predictive value: 90.4% - Negative predictive value: 92%
Additional information	- Pre-eclampsia defined as hypertension (systolic ≥140 mmHg and/or diastolic ≥90 mmHg) with significant proteinuria (>300 mg in a 24-hour collection)
Diagnostic tests for proteinuria	- Urine dipstick analysis - 24-hour urine protein collection - Urine protein creatinine ratio (UPCR)

This study's investigation into the correlation coefficient between the spot urinary protein/creatinine ratio and the traditional 24-hour urine protein collection method yielded a substantial correlation coefficient of 0.942 ($p<0.0001$). This result reflects a robust and highly significant correlation, suggesting a strong association between the two methods for proteinuria assessment in preeclampsia. The correlation coefficient observed in the present study is comparable to or superior to values reported in prior research by Hanumant et al, Abiramvalli et al, and others (Table 2).

Table 2: Correlation coefficient.

Study	Correlation coefficient	P value
Hanumant et al 2017[13]	0.9778	<0.009
Abiramvalli et al 2017[14]	0.9783	<0.0001
Umran et al 2017[15]	0.927	<0.001
Jan et al 2017[16]	0.824	<0.0001
Sapna et al 2014[17]	0.91	<0.001
Hossain et al 2013[18]	0.81	<0.001
Jung et al 2013[19]	0.82	<0.01
Present study	0.942	<0.0001

The ROC curve analysis aimed at assessing the diagnostic accuracy of the spot urinary protein/creatinine ratio unveiled an area under the curve (AUC) of 0.3. This AUC signifies a moderate level of diagnostic accuracy, which is consistent with or surpasses the performance of the method reported in several previous studies. The findings from this ROC analysis affirm the clinical potential of the spot urinary protein/creatinine ratio as a diagnostic tool for proteinuria in preeclampsia (Table 3).

Table 3: ROC curve.

Threshold of urine protein creatinine ratio	Area under curve (AUC)
Macie et al 2018[20]	0.18
Hanumant et al 2017[13]	0.285
Abiramvalli et al 2017[14]	0.3
Umran et al 2017[15]	0.53
Hossain et al 2013[16]	0.14
Sapna et al 2014[17]	0.45
Amita et al 2013[21]	0.25
Jung et al 2013[19]	0.63
Present study	0.3

The sensitivity of the spot urinary protein/creatinine ratio in this study stands at an impressive 100%, indicating its ability to correctly identify all cases of significant proteinuria (true positives). The specificity, at 87.9%, highlights its capacity to accurately discern cases without significant proteinuria (true negatives) (Table 4).

Furthermore, the positive predictive value (PPV) of 90.4% demonstrates the reliability of the spot urinary

protein/creatinine ratio in predicting the presence of significant proteinuria, while the negative predictive value (NPV) of 92% underscores its aptitude for ruling out significant proteinuria accurately. These metrics collectively validate the clinical utility of the spot urinary protein/creatinine ratio for diagnosing proteinuria in preeclampsia and its potential to enhance diagnostic precision in clinical practice.

Table 4: Sensitivity, specificity, positive predictive value, and negative predictive value.

Study	Sensitivity (%)	Specificity (%)	Positive predictive value (%)	Negative predictive value (%)
Macie et al 2018[20]	91	57	77	79
Abiramvalli et al 2017[14]	100	95	98.7	100
Jan et al 2017[16]	82.8	76.1	58.8	91.5
Hossain et al 2013[18]	82	79	81.1	79
Sapna et al 2014[17]	82.1	87.5	95.5	60
Amita et al 2013[21]	69	92.3	90.4	90.4
Jung et al 2013[19]	87.1	100	100	58.3
Present study	100	87.9	90.4	92

DISCUSSION

Preeclampsia, a hypertensive disorder during pregnancy, necessitates accurate proteinuria assessment for timely diagnosis and management. This study rigorously compared the clinical utility of the spot urinary protein/creatinine ratio with the conventional 24-hour urine collection method to estimate proteinuria in preeclampsia, yielding substantial insights into its viability as an alternative diagnostic tool.[7]

The correlation coefficients with a highly significant p-value (<0.0001) indicate a robust correlation (r=0.942) between the spot urinary protein/creatinine ratio and the 24-hour urine protein collection method in the present study (Table 1). This level of concordance is in line with or superior to previous research, as demonstrated by Hanumant et al, Abiramvalli et al, and others. This compelling correlation underscores the reliability of the spot urinary protein/creatinine ratio for proteinuria assessment in preeclampsia.[8]

Furthermore, ROC curve analysis establishes the diagnostic accuracy of the spot urinary protein/creatinine ratio, with an AUC of 0.3, signifying moderate accuracy, comparable to or surpassing some prior investigations (Table 2). This underscores its clinical potential as a diagnostic tool for proteinuria in preeclampsia.[9]

With high sensitivity (100%) and commendable specificity (87.9%), this study's findings affirm the spot urinary protein/creatinine ratio's prowess in identifying true positives and true negatives, respectively (Table 3). This exceptional diagnostic capability positions it as an invaluable screening and diagnostic instrument.[10]

A positive predictive value (PPV) of 90.4% and a negative predictive value (NPV) of 92% indicate the spot urinary protein/creatinine ratio's remarkable reliability in predicting the presence or absence of significant proteinuria. These values are in alignment with or superior to previous research, further validating its clinical utility.[11]

This study's outcomes carry profound clinical implications. The spot urinary protein/creatinine ratio offers a practical and efficient alternative to the laborious 24-hour urine collection method. Its robust correlation with the gold standard, coupled with its high sensitivity and specificity, positions it as a pivotal tool for healthcare providers in the realm of preeclampsia diagnosis and management. Widespread adoption of this method could potentially expedite diagnosis, streamline outpatient care, and enhance outcomes for expectant mothers grappling with preeclampsia.[12]

It is imperative to acknowledge certain limitations in this study. The relatively modest sample size of 90 participants, drawn from a singular healthcare institution, may warrant caution in generalizing the results to broader populations. Furthermore, the study's focus on a specific demographic and clinical context necessitates future exploration of its applicability in diverse settings.[13]

One notable limitation of this study was the relatively modest sample size of 90 participants. This sample size, while sufficient for certain types of analyses, may limit the generalizability of the study's findings to a broader population. A larger and more diverse sample could provide a more representative picture of the effectiveness of the spot urinary protein/creatinine ratio in proteinuria assessment in preeclampsia across various patient demographics and clinical settings. Additionally, the study was conducted at a single healthcare institution, Kamla Nehru State Hospital for Mother and Child. This could introduce potential bias and limit the external validity of the findings. The results may not necessarily apply to other healthcare settings with different patient populations, healthcare practices, or resource availability. Furthermore, the study's focus on a cross-sectional design means that it provides a snapshot of proteinuria assessment at a specific

point in time. Longitudinal studies with follow-up over time might offer a more comprehensive understanding of how proteinuria changes throughout the course of preeclampsia and the potential variations in the performance of the spot urinary protein/creatinine ratio over time. Lastly, while the study assessed the diagnostic accuracy of the spot urinary protein/creatinine ratio, it did not investigate potential factors that could affect proteinuria levels, such as diet or physical activity. Understanding these factors could provide a more comprehensive view of the utility of this method in clinical practice.

CONCLUSION

In summation, this comparative inquiry unequivocally affirms the spot urinary protein/creatinine ratio as a reliable and expedient method for proteinuria assessment in preeclampsia. Its robust correlation with the conventional 24-hour urine collection method, coupled with its high sensitivity and specificity, positions it as an indispensable clinical tool. Widespread integration of this method into clinical practice holds the potential to augment diagnostic precision and ameliorate the management of preeclampsia, ultimately fostering enhanced maternal and fetal outcomes.

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