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Original Research Paper

Biochemistry

BIOCHEMICAL AND ELECTROLYTE ALTERATIONS AMONG TUBERCULOSIS PATIENTS

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ABSTRACT

Background: Tuberculosis (TB) remains a major public health problem worldwide. Diabetes mellitus and prediabetes are increasingly associated with tuberculosis and may contribute to various biochemical and electrolyte abnormalities, adversely affecting disease outcome and management. **Aim:** To assess biochemical and electrolyte alterations among pulmonary tuberculosis patients. **Materials and Methods:** A hospital-based cross-sectional observational study was conducted in the Department of Biochemistry in collaboration with the Department of Respiratory Medicine at Agartala Government Medical College & GB Pant Hospital over a period of two years. A total of 100 newly diagnosed pulmonary tuberculosis patients were included in the study. Serum sodium, potassium, and chloride were analyzed using EasyLyte Electrolyte Autoanalyzer. HbA1c was estimated by High-Performance Liquid Chromatography (HPLC), while lipid profile and liver function tests were estimated using a fully automated analyzer. **Results:** Among the study participants, 54% were diabetic, 19% were prediabetic, and 27% were normoglycemic. Elevated HbA1c, random blood sugar, liver enzymes, and altered lipid parameters were observed. Serum sodium levels were reduced, while potassium and chloride alterations were noted among diabetic and prediabetic tuberculosis patients. Significant association was observed between glycemic parameters and serum electrolyte levels ($p < 0.05$). **Conclusion:** The present study demonstrated significant biochemical and electrolyte alterations among diabetic and prediabetic tuberculosis patients. Early screening and monitoring of glycemic status and electrolyte imbalance may improve clinical management and reduce complications among tuberculosis patients.

KEYWORDS : Pulmonary tuberculosis, dyseletrolytemia, HbA1c

INTRODUCTION

Tuberculosis (TB) is one of the leading infectious diseases worldwide and remains a major public health problem, particularly in developing countries such as India.[1] Despite advances in diagnosis and treatment, tuberculosis continues to contribute significantly to morbidity and mortality. The interaction between tuberculosis and diabetes mellitus has emerged as an important global health concern because diabetes increases the susceptibility to tuberculosis and adversely affects treatment outcomes.[2]

Biochemical abnormalities are frequently observed among tuberculosis patients due to chronic inflammation, malnutrition, oxidative stress, and adverse effects of anti-tubercular therapy.[3] Alterations in liver function parameters are particularly important because anti-tubercular drugs are potentially hepatotoxic. Elevated levels of serum transaminases and alkaline phosphatase have been reported among tuberculosis patients receiving anti-tubercular treatment.[4]

Electrolyte disturbances such as hyponatremia, hypokalemia, and altered chloride levels are also common among tuberculosis patients.[5] These abnormalities may occur due to dehydration, adrenal involvement, syndrome of inappropriate antidiuretic hormone secretion, renal dysfunction, and poor nutritional status. Diabetes mellitus may further aggravate electrolyte imbalance due to osmotic diuresis and metabolic disturbances.[6]

Dyslipidemia is another important biochemical abnormality associated with diabetes mellitus. Altered triglyceride and cholesterol levels are commonly observed in diabetic individuals due to impaired lipid metabolism and insulin resistance.[7] In tuberculosis patients, chronic infection and inflammatory stress may additionally contribute to lipid abnormalities.

Considering the increasing coexistence of tuberculosis and dysglycemia, evaluation of biochemical and electrolyte alterations among diabetic and prediabetic tuberculosis patients is clinically important for early diagnosis, better management, and prevention of complications. Therefore, the present study was undertaken to assess biochemical and electrolyte alterations among diabetic and prediabetic tuberculosis patients.

AIMS :

1. To assess biochemical and electrolyte parameters among pulmonary tuberculosis patients.

MATERIALS AND METHODS

Study Design- Hospital based Cross-sectional observational study

Study Period- 2 years. The recruitment period was of 1.5 years.

Place of study –The study was conducted in the Department of Biochemistry, AGMC & GB Pant Hospital in collaboration with Department of Respiratory Medicine, AGMC & GB Pant Hospital.

Study population – Newly diagnosed pulmonary tuberculosis patients attending the Department of Respiratory Medicine, AGMC & GB Pant Hospital.

Sample Size Calculations- For quantitative component of this study, minimum sample size requirement is determined by the formula "$n = z2 \times p \times q \div d2$". Here, n is sample size; Z is the standard normal deviate and its value at 5% level of significance is 1.96; p is the proportion of electrolyte imbalance as Kaur J et al and it is 50%; q= 100 – 50= 50; d is absolute error, which was considered as 10% in this study. Hence, sample size $n = \{(1.96)2\times 50\times 50\} \div 102 = 96=100$ (Rounded). [8] Thus 100 patients were included in the quantitative component of this study.

Inclusion criteria-

- Newly diagnosed Pulmonary Tuberculosis patients attending AGMC & GB Pant Hospital, Tripura
- Patients willing to give informed consent.

Exclusion criteria-

- Pulmonary Tuberculosis patients <18 years.
- All extra pulmonary Tuberculosis Patients.

METHODS:

a) Serum Na^+, K^+ and Cl^- was analysed by Easylyte Electrolyte Autoanalyzer .
b) HbA1c was estimated by High-performance liquid chromatography (HPLC):
c) Serum Lipid profile and liver function tests were done by Full auto analyser (XL-640)

Normal Reference Values of Study Parameters:

Parameter	Normal Reference Value	Reference
HbA1c	Normal: <5.7% | Prediabetes: 5.7–6.4% | Diabetes: ≥6.5%	American Diabetes Association.[9]
Random Blood Sugar (RBS)	70–140 mg/dL	American Diabetes Association.[9]
Triglycerides	<150 mg/dL	National Cholesterol Education Program (NCEP ATP III).[10]
Total Cholesterol	<200 mg/dL	NCEP ATP III.[10]
SGOT (AST)	5–40 IU/L	Burtis CA et al.[11]
SGPT (ALT)	7–56 IU/L	Burtis CA et al.[11]
ALP	44–147 IU/L	Burtis CA et al.[11]
Total Protein	6.0–8.3 g/dL	Burtis CA et al.[11]
Serum Sodium (Na^+)	135–145 mEq/L	Palmer BF et al.[12]
Serum Potassium (K^+)	3.5–5.0 mEq/L	Palmer BF et al.[12]
Serum Chloride (Cl^-)	98–106 mEq/L	Palmer BF et al.[12]

Data Management: Statistical analysis was performed using SPSS version 25.0 for Windows.
p value <0.05 was considered significant.

Ethical consideration: Written informed consent was obtained from all participants and the study was conducted only after obtaining approval from the Institutional Ethics Committee of Agartala Government Medical College. Data obtained from this study was kept confidential and used for research purposes only.

OBSERVATIONS:

Table 1: Age Distribution of Study Population

Age (Mean age in yrs ± SD)	Male (Mean age in yrs ± SD)	Female (Mean age in yrs ± SD)
45.49 ± 12.78	41.71 ± 11.92	50.06 ± 8.46

Table 1 shows the age distribution of the study population. The mean age of the participants was 45.49 ± 12.78 years. The mean age among male participants was 41.71 ± 11.92 years, while among female participants it was 50.06 ± 8.46 years, indicating relatively higher mean age among females.

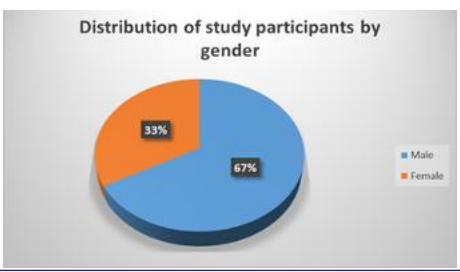

Figure 1: Gender Distribution of Study Population

Figure 1 shows the gender distribution of the study population. Male participants constituted 67% of the study population, while female participants constituted 33%, indicating male predominance among tuberculosis patients.

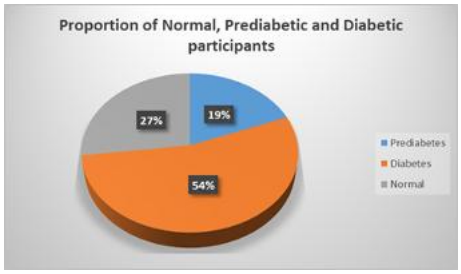

Figure 2: Distribution of Normal, Prediabetic and Diabetic Tuberculosis Patients

In Figure 2, 54% were diabetic, 19% were prediabetic, and 27% were normoglycemic, indicating a high prevalence of dysglycemia among tuberculosis patients.

Table 2: Distribution of HbA1c Levels among Male and Female Tuberculosis Patients

HbA1c Total (%±SD)	Male (%±SD)	Female (%±SD)	p value
6.92 ± 0.79	6.94 ± 0.79	6.87 ± 0.81	**<0.05**

In Table 2, the mean HbA1c level among the study participants was 6.92 ± 0.79%. Male participants had slightly higher HbA1c levels (6.94 ± 0.79%) compared to female participants (6.87 ± 0.81%). The difference was statistically significant ($p < 0.05$).

Table 3: Distribution of Random Blood Sugar Levels among Male and Female Tuberculosis Patients

RBS Total (mg/dl±SD)	Male (mg/dl±SD)	Female (mg/dl±SD)	p value
237.68 ± 102	256.64 ± 112.71	202.94 ± 63.67	**<0.05**

Table 3 shows the distribution of random blood sugar levels among male and female tuberculosis patients. The mean random blood sugar level among the study participants was 237.68 ± 102 mg/dL. Male participants showed higher random blood sugar levels (256.64 ± 112.71 mg/dL) compared to female participants (202.94 ± 63.67 mg/dL). The difference was statistically significant ($p < 0.05$)

Table 4: Distribution of Serum Lipid Profile among Male and Female Tuberculosis Patients

Serum Lipid profile	Total (mg/dl±SD)	Male (mg/dl±SD)	Female (mg/dl±SD)	p value
Triglyceride	134.97 ± 31.35	136.58 ± 34.92	133.10 ± 22.23	**<0.05**
Cholesterol	113.33. ± 28.90	116.66 ± 28.90	106.58 ± 35.44	

Table 4 shows the distribution of serum lipid profile among male and female tuberculosis patients. The mean serum triglyceride level among the study participants was 134.97 ± 31.35 mg/dL. Male participants had slightly higher triglyceride levels compared to females. The mean cholesterol level was 113.33 ± 28.90 mg/dL, with relatively higher levels observed among male participants. The findings indicate altered lipid metabolism among diabetic and prediabetic tuberculosis patients.

Table 5: Distribution of Liver Function Parameters among Male and Female Tuberculosis Patients

Liver profile	Total	Male	Female	p value
SGOT (IU/L ±SD)	69.87 ± 99.79	59.63 ± 69.34	90.67 ± 142.22	
SGPT (IU/L±SD)	64.61 ± 54.29	56.18 ± 29.85	81.73 ± 82.63	**<0.05**

ALP (IU/L±SD)	214.04 ± 142.65	228.60 ± 165.82	184.48 ± 70.01	
Protein (g/dl±SD)	6.26 ± 0.96	6.27 ± 0.84	6.26 ± 1.18	

Table 5 shows the distribution of liver function parameters among male and female tuberculosis patients. Elevated levels of SGOT, SGPT, and ALP were observed among the study participants. Female participants showed relatively higher SGOT and SGPT levels, while male participants had higher ALP levels. These findings suggest hepatic involvement and possible hepatocellular injury among tuberculosis patients.

Table 6: Distribution of Serum Electrolyte Levels among Male and Female Tuberculosis Patients

Serum Electrolytes (Total)	Total	Male	Female	p value
Na (mEq/L±SD)	133.04 ± 5.64	133.25 ± 5.71	132.47 ± 5.59	**<0.05**
K (mEq/L±SD)	3.93 ±.74	4.05 ± 0.649	3.69 ± 0.860	
Cl (mEq/L±SD)	103.97 ± 1.45	103.64 ± 1.36	104.64 ± 1.43	

Table 6 shows the distribution of serum electrolyte levels among male and female tuberculosis patients. The mean serum sodium level was 133.04 ± 5.64 mEq/L, potassium level was 3.93 ± 0.74 mEq/L, and chloride level was 103.97 ± 1.45 mEq/L. Male participants had slightly higher sodium and potassium levels, whereas female participants showed relatively higher chloride levels. The differences were statistically significant ($p < 0.05$)

Table 7: Association of Glycemic Parameters with Serum Electrolytes among Tuberculosis Patients

Parameters	Electrolytes			p value
	Na **(mEq/L± SD)**	K **(mEq/L± SD)**	Cl **(mEq/L± SD)**	
HbA1c (%±SD) = 6.92 ± 0.79	133.04 ± 5.64	3.93 ±.74	103.97 ± 1.45	**<0.05**
RBS(mg/dl±SD) 237.68 ± 102				

In Table 7, increased HbA1c and random blood sugar levels were associated with alterations in serum sodium, potassium, and chloride levels. The association was statistically significant ($p < 0.05$), indicating that poor glycemic control may contribute to electrolyte imbalance among tuberculosis patients.

Table 8: Association of Serum Electrolyte Levels among Normal, Prediabetic, and Diabetic Tuberculosis Patients

Serum electrolytes	Prediabetes	Diabetes	Normal	p value
Na (mEq/L±SD)	129.47± 3.75	136.39± 4.54	128.85± 4.29	**<0.05**
K (mEq/L±SD)	3.70 ± 0.70	4.16±0.71	3.63±0.70	
Cl (mEq/L±SD)	104.05 ± 1.47	103.96± 1.50	103.93± 1.38	

In Table 8, diabetic participants showed relatively higher sodium and potassium levels compared to prediabetic and normal participants. Chloride levels showed minimal variation among the groups. The findings indicate significant electrolyte alterations associated with dysglycemia among tuberculosis patients ($p < 0.05$).

DISCUSSION:

The present study evaluated biochemical and electrolyte alterations among diabetic and prediabetic tuberculosis patients. The mean age of the study participants was 45.49 ± 12.78 years, with a higher proportion of male participants compared to females. Similar male predominance among tuberculosis patients has been reported in previous studies, possibly due to increased environmental exposure, smoking, alcohol consumption, and occupational risk factors.[13]

In the present study, a high prevalence of dysglycemia was observed among tuberculosis patients, with 54% diabetic, 19% prediabetic, and 27% normoglycemic individuals. Similar findings were reported by Viswanathan et al., who observed increased prevalence of diabetes and prediabetes among tuberculosis patients in India.[14] The coexistence of tuberculosis and diabetes may worsen immune dysfunction and adversely affect treatment outcomes.

The mean HbA1c level in the present study was 6.92 ± 0.79%, indicating poor glycemic control among study participants. Chronic hyperglycemia impairs macrophage and lymphocyte function and increases susceptibility to active tuberculosis.[15] Jeon and Murray also reported that diabetes mellitus significantly increases the risk of tuberculosis infection.[2]

Random blood sugar levels were elevated among the study population, particularly among male participants. Stress-induced hyperglycemia, inflammatory cytokine release, and underlying diabetes mellitus may contribute to elevated blood glucose levels among tuberculosis patients.

The present study demonstrated altered lipid parameters among diabetic and prediabetic tuberculosis patients. Serum triglyceride levels were elevated among the study participants. Similar findings were reported by Mooradian, who observed dyslipidemia among diabetic individuals due to insulin resistance and altered lipid metabolism.[7]

Liver function parameters including SGOT, SGPT, and ALP were elevated in the present study. These abnormalities may be attributed to hepatocellular injury, chronic inflammation, metabolic stress, and hepatotoxic effects of anti-tubercular drugs. Sharma et al. similarly reported elevated liver enzymes among tuberculosis patients receiving anti-tubercular therapy.[4]

Electrolyte abnormalities were also observed among the study participants. Serum sodium levels were relatively reduced, while potassium and chloride alterations were noted among diabetic and prediabetic tuberculosis patients. Similar electrolyte disturbances among tuberculosis patients were reported by Oluboyo and Erasmus.[5] Hyponatremia in tuberculosis may occur due to chronic infection, adrenal insufficiency, syndrome of inappropriate antidiuretic hormone secretion, and dehydration.[16]

The present study also demonstrated an association between glycemic parameters and serum electrolytes. Hyperglycemia can lead to osmotic diuresis and electrolyte loss, thereby contributing to sodium and potassium imbalance.[6]

CONCLUSION

The present study demonstrated significant biochemical and electrolyte alterations among diabetic and prediabetic tuberculosis patients. Elevated HbA1c, altered lipid profile, liver enzyme abnormalities, and electrolyte imbalance were observed among the study participants. Early screening and monitoring of glycemic status and biochemical parameters among tuberculosis patients may help in improving disease management and reducing complications.

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