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Original Research Article

Levels of adenosine deaminase and lactate dehydrogenase in the serum and CSF of TB meningitis patients

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Abstract

Background: The high mortality rate of tuberculosis, along with the fact that it is one of the oldest human diseases, has made it a major focus of study for medical professionals in every corner of the globe. This bacterial infection, which is caused by the Mycobacterium tuberculosis complex, mostly affects the lungs but, in up to a third of patients, can spread to other regions of the body.
Methods: From December 2015 to May 2017, researchers from the Biochemistry department at MGM Hospital, a TB chest hospital in Warangal, did a case control study. The samples come from the TB and chest departments of MGM Hospital in Warangal and the general medicine department.
Results: The current research was carried out in MGM hospital in Warangal, India, specifically in the Biochemistry, General Medicine, and Tuberculosis and Chest Diseases Departments. Fifty participants with confirmed or strongly suspected tuberculous meningitis and fifty healthy controls were enrolled in the study. The levels of ADA, LDH, glucose, and protein were all reported in international units per liter.
Conclusion: Scientists and researchers in the fields of Tuberculosis and Chest Disease and General Medicine carried out the current study. The study included a total of 100 participants. There were 50 patients with confirmed or suspected TB meningitis and 50 controls.

Keywords: Adenosine deaminase, lactate dehydrogenase, serum, TB meningitis

Introduction

The world's attention has long been focused on tuberculosis because it is one of the world's oldest human diseases and has the greatest fatality rate of any infectious disease. Mycobacterium tuberculosis complex bacteria are responsible for this illness, which often manifests in the lungs but can spread to other organs in up to a third of cases [1]. Among the leading causes of death around the world, tuberculosis (TB) is in the top 10. There were 10.4

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million new cases of tuberculosis in 2016, with 1.7 million fatalities (including 0.4 million among people with HIV). One million kids got tuberculosis and 2,50,000 kids died from it in 2016. Among those living with HIV, tuberculosis (TB) was the major cause of death in 2016 (40% of all HIV-related deaths). More than ninety-five percent of TB fatalities happen in low- and middle-income nations.

India accounts for 64 percent of the total, with the other six countries being Indonesia, China, the Philippines, Pakistan, Nigeria, and South Africa. Multidrug-resistant tuberculosis (MDR-TB) remains a major threat to public health and national security despite tremendous advances in fighting the illness. Six million new instances of rifampicin-resistant tuberculosis were reported, with an additional 4,900,000 cases of multidrug-resistant TB, according to the World Health Organization (WHO). The global TB rate is dropping at about 2% each year. This rate of decline needs to increase to 4-5% every year in order to meet the End TB Strategy's 2020 targets. It is estimated that 53 million lives were saved due to TB identification and treatment between the years 2000 and 2016. Achieving a world free of tuberculosis by 2030 is one of the health-related targets set by the Sustainable Development Goals. TB is currently ranked tenth among worldwide diseases and is predicted to remain this place (or potentially move up to seventh by 2020 [2]), despite being the biggest cause of death from a single infectious factor (more so than AIDS, malaria, or measles). Meningitis is a collection of symptoms brought on by meningeal inflammation [3]. Both viral and noninfectious variables have an impact. Chronic meningitis results from some infectious causes of meningitis and is characterized by the prolonged manifestation of meningitis symptoms (weeks to months). Among this population, tuberculous meningitis is the most common form of the disease [4]. Tuberculosis is the leading cause of three different types of central nervous system infections: meningitis, intracranial tuberculoma, and spinal infection. Such CNS infections are typical in regions where tuberculosis is widespread [3, 4]. Roughly 5% of those who become infected with tuberculosis will really develop the disease [5]. As the most dangerous form of extra pulmonary tuberculosis (TB), tuberculous meningitis (TBM) remains a major global health problem [6].

Due to the fact that the clinical outcome of TB meningitis is greatly reliant on the stage at which therapy is initiated, early detection is of essential relevance [3]. TBM is often discovered after substantial brain damage has already occurred [7-9] due to the nonspecific and unpredictable nature of the clinical features. The classic triad of meningitis includes fever (adults, 60%-95%; children, 67%), headache (adults, 50%-80%; children, 25%), and signs of meningismus (adults, 40%-80%; children, 98%). More kids than adults show up to the emergency room with mental impairment [9]. Meningiomas in the elderly are associated with an increased risk of seizures, and the symptoms of these tumors may be obscured by age [10]. It has been found that people with HIV co-infection are less likely to experience fever, headache, and meningismus, but more likely to experience mental state alterations [11, 12].

No firm diagnosis of TBM may be made or ruled out based only on clinical presentation. Active tuberculosis diagnosis is notoriously difficult, with results often being equivocal. The diagnostic procedures for TBM were analyzed, and it was shown that they all had low sensitivity and specificity. Only in some instances [13, 14] is there hard proof that acid fast bacilli (AFB) are to blame. Although some additional tests are effective, they may be too expensive for frequent usage [15–17], and most of the tests designed for the early identification of meningitis are not sensitive. Because of this, a speedy method for diagnosing meningitis and distinguishing between its many forms must be introduced, preferably one that is simple, reliable, and inexpensive.

Materials and Methods

From December 2015 to May 2017, researchers from the Biochemistry department at MGM Hospital, a TB chest hospital in Warangal, did a case control study. The samples come from the TB and chest departments of MGM Hospital in Warangal and the general medicine department. The research was conducted in the Kakatiya Medical College/MGM Hospital in Warangal,

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specifically in the Biochemistry department. One hundred people were enlisted for the study, 50 of them were confirmed to have tuberculous meningitis while the remaining 50 served as healthy controls.

Inclusion criteria

1. Patients of both sexes between the ages of 20-40 yrs.
2. Patients presenting to MGM hospital & Tb chest hospital Warangal diagnosed with Tubercular Meningitis.
3. Patients presenting to MGM hospital & Tb chest hospital Warangal, clinically suspected cases of Tubercular Meningitis.

Exclusion criteria

1. Patients <20 yrs and >40 yrs.
2. Patients not having Tubercular meningitis (Pyogenic, Fungal, viral and Parasitic meningitis patients)

Specimen collection

CSF collected by lumbar puncture with all aseptic precaution by clinician and serum sample is collected in sterile screw capped tubes. All samples were stored at 4°c and estimated within 24 hours.

Methods

1. Estimation of CSF ADA

CSF & Serum samples collected from patients diagnosed and suspected to have Tubercular Meningitis were analyzed for levels of Lactate Dehydrogenase and Adenosine deaminase. The procedures for estimation have been described below.

Table 1: Estimation of ADA

Sl.no	Reagents	Reagent	Standard	Sample B	Sample T
1	Phosphate Buffer	1.00 ml	-------	-------	-------
2	Buffered Adenosine Solution	-------	-------	1.00 ml	1.00 ml
3	Ammonium Sulphate Std Solution	-------	1.00 ml	-------	-------
4	Sample	-------	-------	-------	0.05 ml
5	Water	0.05 ml	0.05 ml	-------	-------
Mixed and plugged the tubes with cotton, incubated at 37^0c for 60 minutes.					
6	Phenol/Nitroprusside	3.0 ml	3.0 ml	3.0 ml	3.0 ml
7	Sample	-------	-------	0.05 ml	-------
8	Alkaline Hypochlorite	3.0 ml	3.0 ml	3.0 ml	3.0 ml
Mixed well and incubated at 37 °C for 15min. Measured the absorbance of all against distilled water at 630nm.					

Calculations

Concentration of ADA (U/L) = Abs.T-Abs.TB / Abs.S-Abs.RB x 50(U/Lit)

Linearity

If the absorbance exceeded 1.00, diluted the sample 2.5 times and repeat assay and express value multiplied with the dilution factor.

Table 2: Standardisation of ammonium sulphate

Reagent(ml)	S1	S2	S3	S4	S5	BLANK
Working standard	0.2 ml	0.4ml	0.6 ml	0.8 ml	1 ml	-
Distilled water	0.8ml	0.6ml	0.4ml	0.2ml	-	1ml
Phenol Nitroprusside	3 ml	3ml	3ml	3ml	3ml	3ml
Alkaline hypochlorite	3ml	3ml	3ml	3ml	3ml	3ml
Incubate for 30 minutes in 37 degrees centigrade water bath and read at 630 nm						
Concentrations(nmol/L)	10	20	30	40	50	-
Absorbance	0.10	0.20	0.30	0.42	0.48	-

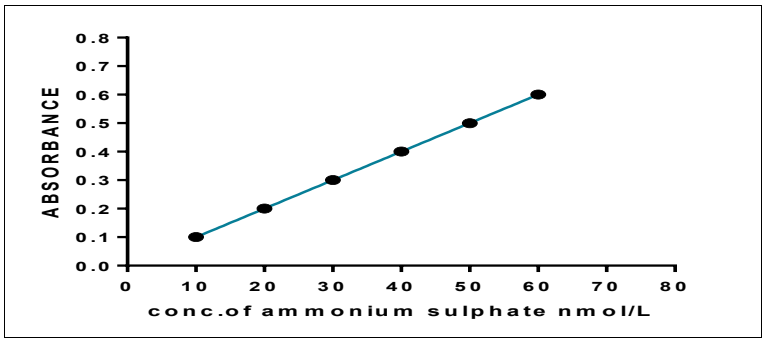
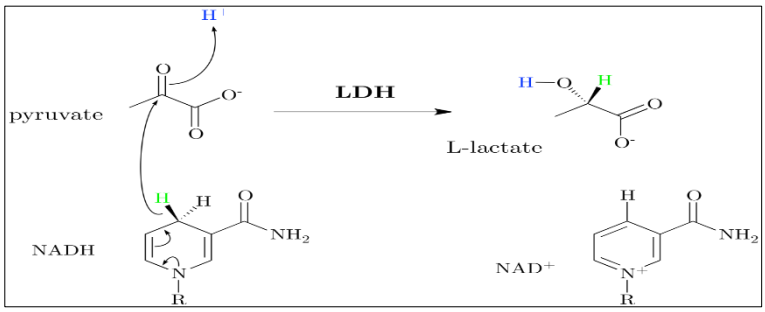


Fig 1: Standardisation of ammonium sulphate

Estimation of lactate dehydrogenase

Incubating the sample with the coenzyme NADH2 causes pyruvate to be decreased. Adding phenyl hydrazine solution causes the remaining pyruvate to react with the hydrazine, stopping the process. Amount of unreacted pyruvate can be determined by observing the degree to which hydrazine turns brown when exposed to an alkaline solution. Since some lactate dehydrogenase is heat-sensitive, the assay is carried out at room temperature.



Procedure

Sample was collected in plain bottles & enzyme estimations were carried out on the same day or the sample was preserved at temperature 4◦C & was estimated within 24 hours.

Table 3: Reagent Composition

Sr. No	Reagents	Test	Control	Blank
1	Buffered substrate	1 ml	1 ml	-
2	sample	0.2 ml	-	-
Place the mixture in a water bottle at 25 °C				
3	NADH	0.1 ml	-	-
4	Buffer phosphate	-	0.2 ml	0.2 ml
Incubate for exactly 15 min. remove the tube from the bath & add				

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5	2,4DNPH	1 ml	1ml	1 ml
Allow all tubes to stand at room temp. For 20 min & add				
6	0.4 N NAOH	10 ml	10 ml	10 ml
After mixing compare the coloured solutions at 420 nM				

Reagent Composition

Table 4: Glucose reagent

Glucose oxidase	20000 IU/L
Peroxidase	3250 IU/L
4-Aminoantipyrine	0.52 mMol/L
4-Hydroxybenzoic acid	10 mMol/L
Phosphate buffer	110 mMol/L

Also contains non-reactive fillers and stabilizers pH 7.0±0.2 at 25℃
Reagent 2: Glucose diluents with lipid clearing agent
Glucose standard - 100mg/dl (5.55 mmol/L)

Reagent reconstitution

When kept unopened at 2-8 degrees Celsius, the reagent and standard will be stable until their expiration date. To make the working reagent, 500 milliliters of glucose diluent was dissolved in reagent 1. A bottle of amber color that has been kept clean and dry is ideal for long-term storage. After reconstitution, the shelf life of Working Reagent is 90 days at 2-8 °C or 14 days at 25 °C.

Table 5: Preparation on working standards of glucose

	S1	**S2**	**S3**	**S4**	**S5**
Stock glucose std (ml)	0.2	0.4	0.6	0.8	1.0
Isotonic solution (1ml)	0.8	0.6	0.4	0.2	-

Exactly 10µl from each standard were used for calibration curve.

Table 6: Standardization of CSF Glucose

Reagents	**S1**	**S2**	**S3**	**S4**	**S5**	**Blank**
Glucose standard (µl)	10	10	10	10	10	-
Working reagent (µl)	1000	1000	1000	1000	1000	1000
Distilled water (µl)	-	-	-	-	-	10
Concentration (Mg %)	20	40	60	80	100	-
absorbance	0.03	0.06	0.09	0.14	0.18	0.00

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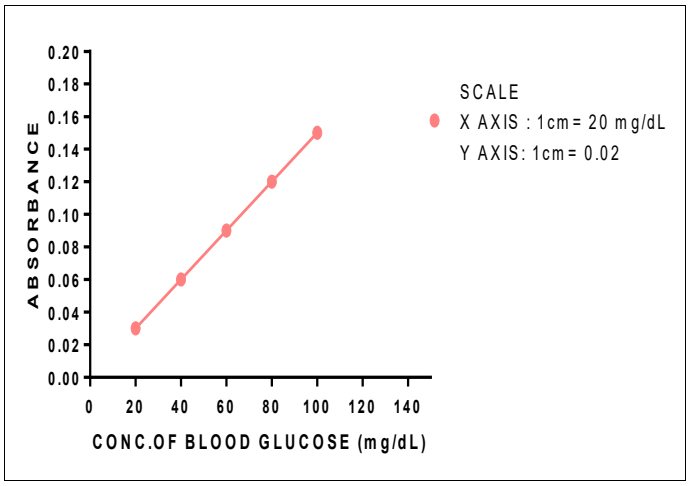

Fig 2: Standardisation of csf glucose

4) Estimation of CSF proteins

Method: Turbidimetric method by 3%sulfosalicylic acid
Principle: Proteins are precipitated by dilute sulfosalicylic acid. The resultant turbidity in uniform suspension is measured against a standard treated similarly in colorimeter at green filter (540nm).

Table 7: Estimation of CSF proteins

Reagent	Test	Standard	Blank
Std protein solution	-	1 ml	-
CSF Sample	1 ml	-	-
3% Sulfosalicylic acid	3 ml	3 ml	4 ml

Mix well and keep at room temperature for 10min and measure absorbance at 540 nm

Table 8: Preparation of working standards of protein

	S1	S2	S3	S4	S5
Stock protein Std (ml)	0.2	0.4	0.6	0.8	1.0
0.9 % Normal saline (ml)	9.8	9.6	9.4	9.2	

Exactly 1ml from each standard were used for calibration curve

Table 9: Showing procedure of standardization of CSF proteins

Reagent	S1	S2	S3	S4	S5	B
Protein standard (ml)	1	1	1	1	1	-
3% Sulfosalicylic acid (ml)	3	3	3	3	3	4
Concentration (mg%)	20	40	60	80	100	-
Absorbance	0.12	0.24	0.36	0.48	0.64	0

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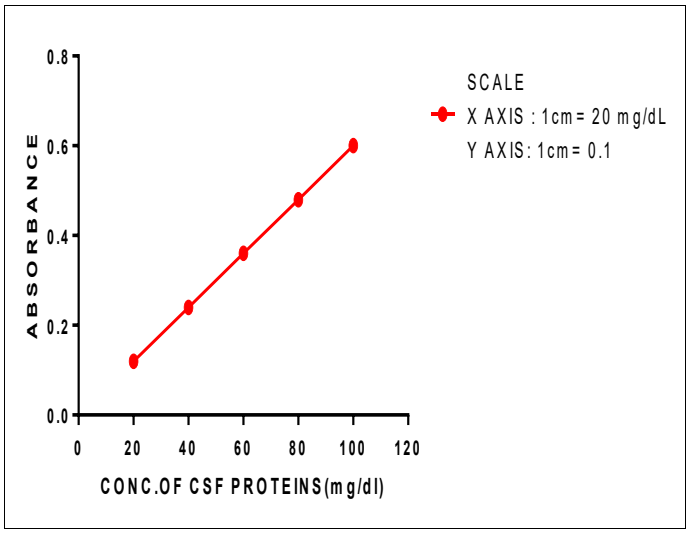

Fig 3: Standardization of csf proteins

Observation and Result

The current research was carried out in MGM hospital in Warangal, India, specifically in the Biochemistry, General Medicine, and Tuberculosis and Chest Diseases Departments. Fifty participants with confirmed or strongly suspected tuberculous meningitis and fifty healthy controls were enrolled in the study. The levels of ADA, LDH, glucose, and protein were all reported in international units per liter. Graph Pad Prism, version 6.0, was used to analyze the data. Mean and standard deviation are used to describe data across groups. The Mean, SD & SEM of all the parameters investigated in the total cases were substantially different from those of controls.

Table 9: Study parameters in all groups

Parameter	Cases			Controls		
	MEAN	SD	SEM	MEAN	SD	SEM
Serum ada	37.54	10.81	1.529	11.56	3.240	0.4582
Csf ada	23.60	4.849	0.6857	6.640	1.156	0.1635
Serum ldh	175.0	9.804	1.387	82.32	8.297	1.173
Csf ldh	117.3	10.71	1.515	28.96	5.707	0.807
Csf glucose	28.90	4.432	0.6268	54.26	5.910	0.8358
		12.32	1.743	29.00	3.642	0.5151

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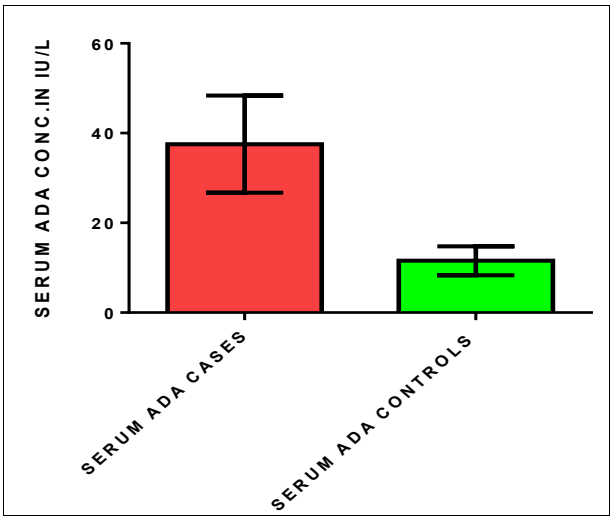

Fig 4: Distribution of serum adrenoceptor beta levels, mean standard deviation

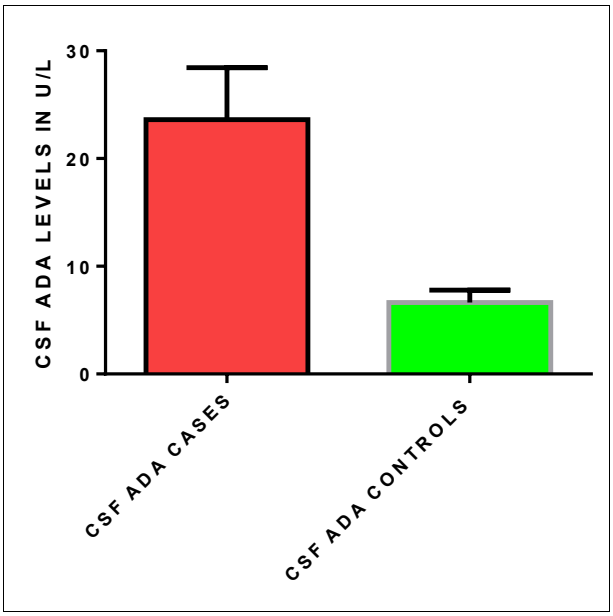

Fig 5: Graph showing the mean and standard deviation of CSF ADA

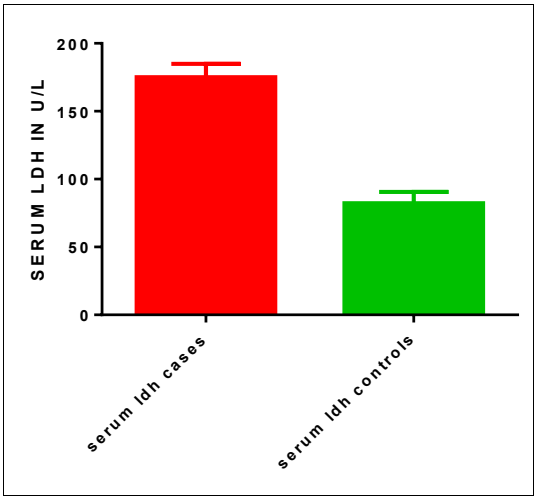

Fig 6: Mean and standard deviation of SERUM LDH shown graphically

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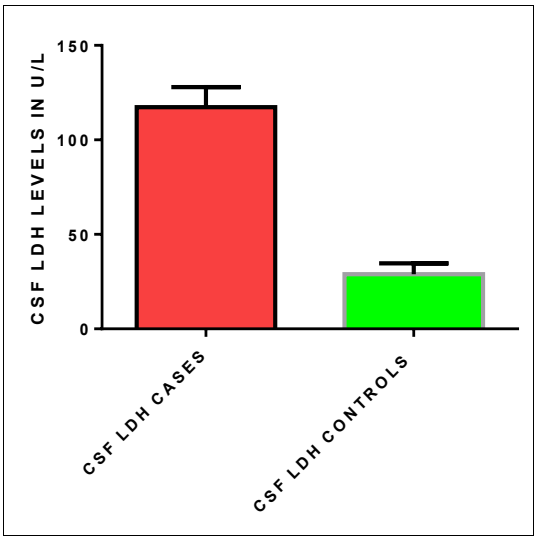

Fig 7: Mean and standard deviation of CSF LDH presented graphically

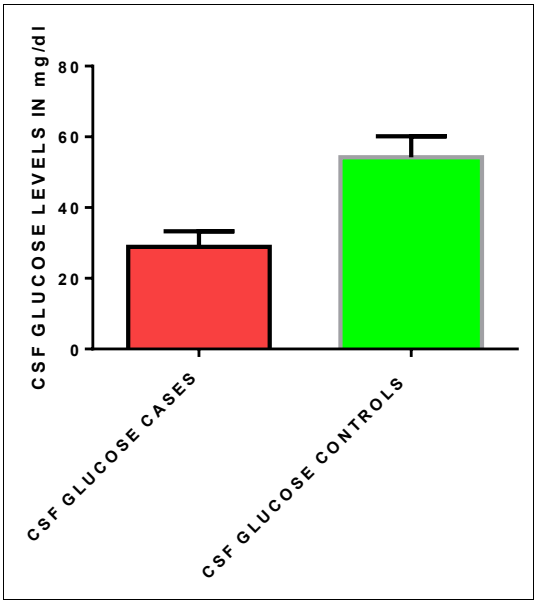

Fig 8: Statistics of CSF GLUCOSE Mean Standard Deviation Pie Chart

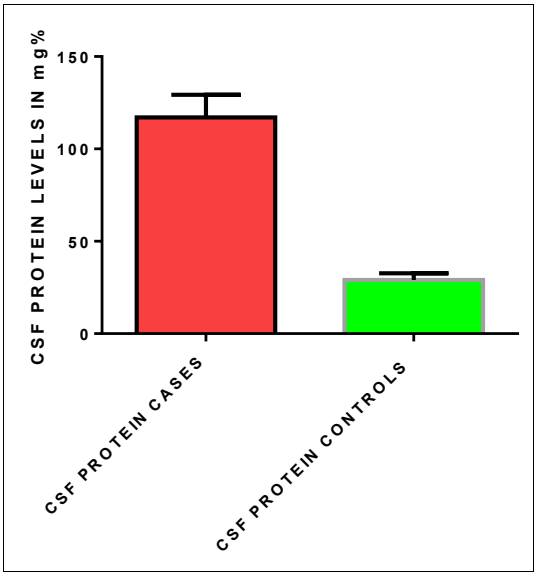

Fig 9: Chart showing the Mean Standard Deviation of Cerebrospinal Fluid Protein

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Table 10: Statistical analysis of two groups using an unpaired t-test

PARAMETER	t-valve	p-valve	Degree of freedom (df)
SERUM ADA	16	<0.0001	98
CSF ADA	24	<0.0001	98
SERUM LDH	51	<0.0001	98
CSF LDH	51	<0.0001	98
CSF GLUCOSE	24	<0.0001	98
CSF PROTEIN	48.42	<0.0001	98

P value was significant in all the parameters (Serum ADA, CSF ADA, Serum LDH, CSF LDH, and CSF Glucose AND CSF Protein)
Pearson's correlation was done to assess the correlation of parameters within the groups.

Table 11: Pearsons correlation between different parameters in cases

		SERUM ADA	CSF ADA	SERUM LDH	CSF LDH	CSF Glucose	CSF Protein
SERUM ADA	Pearsons correlation		0.162	0.215	0.062	-0.024	0.071
	Sig.(2tailed)N		0.260	0.133	0.668	0.869	0.625
CSF ADA	Pearsons correlation	0.162		-0.093	0.210	0.113	0.130
	Sig.(2tailed)N	0.260		0.521	0.144	0.435	0.369
SERUM LDH	Pearsons correlation	0.215	-0.093		-0.102	-0.031	0.051
	Sig.(2tailed)N	0.133	0.521		0.481	0.831	0.726
CSF LDH	Pearsons correlation	0.062	0.210	-0.102		-0.219	0.420
	Sig.(2tailed)N	0.668	0.144	0.481		0.126	0.002
CSF GLUCOSE	Pearsons correlation	-0.024	0.113	-0.031	-0.219		-0.554
	Sig.(2tailed)N	0.869	0.435	0.831	0.126		2.939e-005
CSF PROTEIN	Pearsons correlation	0.071	0.130	0.051	0.420	-0.554	
	Sig.(2tailed)N	0.625	0.369	0.726	0.002	2.939e-005	

Pearsons correlation of cases

Serum ADA was positively correlated with CSF ADA, Serum LDH, CSF LDH & CSF Protein, which was not statistically significant. Serum ADA was negatively correlated with CSF GLUCOSE, which was not statistically significant. CSF LDH was positively correlated with CSF Protein which was statistically significant. CSF Protein was positively correlated with CSF LDH which was statistically significant.

Table 12: Pearsons correlation between different parameters in controls

		Serum ADA	CSF ADA	Serum LDH	CSF LDH	CSF Glucose	CSF Protein
SERUM ADA	Pearsons correlation		-0.087	0.031	-0.161	0.008	0.040
	Sig.(2tailed)N		0.549	0.830	0.264	0.955	0.784
CSF ADA	Pearsons correlation	-0.087		-0.039	0.202	0.124	-0.044
	Sig.(2tailed)N	0.549		0.789	0.160	0.389	0.764
SERUM LDH	Pearsons correlation	0.031	-0.039		-0.098	-0.303	0.065
	Sig.(2tailed)N	0.830	0.789		0.496	0.032	0.655

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CSF LDH	Pearsons correlation	-0.161	0.202	-0.098		0.031	-0.074
	Sig.(2tailed)N	0.264	0.160	0.496		0.833	0.611
CSF GLUCOSE	Pearsons correlation	0.008	0.124	-0.303	0.031		-0.375
	Sig.(2tailed)N	0.955	0.389	0.032	0.833		0.007
CSF PROTEIN	Pearsons correlation	0.040	-0.044	0.065	-0.074	-0.375	
	Sig.(2tailed)N	0.784	0.764	0.655	0.611	0.007	

Pearsons correlation in controls

Serum ADA was positively correlated with serum LDH, CSF GLUCOSE & CSF PROTEIN, which was not statistically significant. Serum ADA was negatively correlated with CSF ADA & CSF LDH which was not statistically significant. Serum LDH was negatively correlated with CSF GLUCOSE which was statistically significant. CSF GLUCOSE was negatively correlated with SERUM LDH which was statistically significant. CSF GLUCOSE was negatively correlated with CSF PROTEIN which was statistically significant.
CSF PROTEIN was negatively correlated with CSF GLUCOSE which was statistically significant.

ROC curve analysis

The most sensitive and specific cut-offs for ADA can be found using ROC analysis, as can its maximal sensitivity and specificity. Selecting a point on the curve that optimizes sensitivity and specificity yields the cut-off value. Area under the curve is useful because it provides objective estimates of sensitivity and specificity. It's an overall representation of how well you can differentiate across the entire exam.

Table 13: Sensitivity, Specificity, best cut off value, Area under curve & P-value, in discriminating cases & control

	Sensitivity	Specificity	Best Cut Off Value	Area Under Curve	P-Value
SERUM ADA	98	100	20	0.9994	0.0001
CSF ADA	100	100	11	1	0.0001
SERUM LDH	100	100	131	1	0.0001
CSF LDH	100	100	70	1	0.0001
CSF GLUCOSE	100	100	40	1	0.0001
CSF PROTEIN	100	100	70	1	0.0001

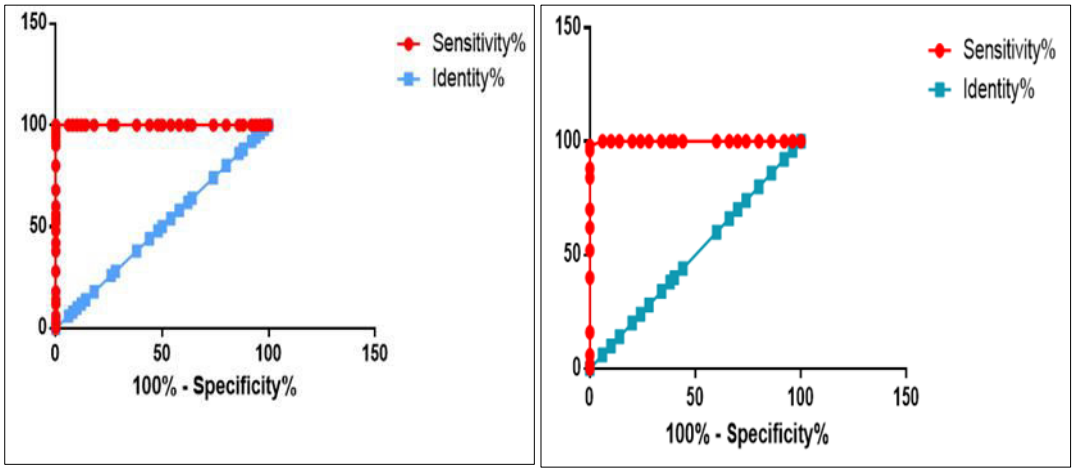

Fig 10: ROC curve of the data

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Discussion

Acute meningitis is an inflammation of the meninges, the membrane that surrounds and protects the brain and spinal cord. Meningitis is a devastating illness that affects people of all ages. Pyogenic and tuberculous meningitis are the most frequent forms in India. When it comes to extra pulmonary tuberculosis, meningitis is one of the scariest possible consequences. The meningeal involvement accounts for around 10% of the roughly 3.70 lakhs annual deaths caused by tuberculosis. TBM shares a clinical presentation that is mostly indistinguishable from that of other forms of meningitis. The neurological symptoms of TBM are quite variable, ranging from no symptoms at all to complete paralysis, stupor, or coma. Squeal can occur in up to 25% of cases [17, 18] due to a delay in diagnosis and the start of appropriate treatment.

Tuberculous meningitis is caused by tuberculous infection spreading to the brain by lymphohematogenous means, which results in a metastatic caseous lesion in the cerebral cortex or meninges. When this initial lesion enlarges, it releases tubercle bacilli into the subarachnoid space in very small numbers [18]. The infiltration of the gelatinous exudate into the cortico-meningeal blood vessels causes inflammation, obstruction, and infarction of the cerebral cortex. Common problems with cranial nerves three, six, and seven come from their links in the brainstem. Hydrocephalus develops when cerebrospinal fluid (CSF) cannot move freely between the ventricular system and the basilar cisterns as a result of the exudate [19-21]. Vasculitis, infarction, cerebral edema, and hydrocephalus are among conditions that can cause significant harm to the brain, either immediately or over time. Severe electrolyte abnormalities related to salt wasting or the syndrome of inadequate antidiuretic hormone secretion further worsen the pathogenesis of tuberculous meningitis, which is already complicated by an already impaired immune system. Very infrequently, years after the initial infection, tuberculous meningitis can develop when a tubercle ruptures beneath the ependyma, releasing tubercle bacilli into the subarachnoid space. How quickly or slowly tuberculous meningitis will progress in the clinic is unknown [20, 21]. Even in wealthy nations, tuberculosis (TBM) has become a major health issue due to the rising HIV infection rate [22, 23]. Due to the heterogeneous clinical manifestations of TBM, an early and accurate diagnosis might be difficult to achieve. Delaying diagnosis and treatment might lead to severe Central Nervous System (CNS) issues [24, 25].

TBM can be diagnosed by cerebrospinal fluid (CSF) tests like culture, PCR, and the cerebrospinal fluid neoantigen antibody testing (CBNAAT) (Cartridge based nucleic acid amplification technique). Such methods are unfeasible in a rural hospital because of their high cost and lengthy implementation time [26]. As a result, there is a requirement for a TBM diagnostic instrument that is sensitive, economical, and capable of detecting the disease at an early stage. This should improve the specificity of Ziehl-Neelsen staining and culture without sacrificing sensitivity [27, 28].

The most common laboratory procedure used for a final diagnosis of TBM is demonstrating the presence of tubercle bacilli via smear and/or culture. Direct smear techniques are rarely successful in detecting growth in CSF samples, while MTB culture takes 4-6 weeks to exhibit growth [29, 30]. In low-resource areas, access to and evaluation of cutting-edge techniques like polymerase chain reaction (PCR)-based amplification of bacterial DNA are limited. The PCR technique may detect a target with a sensitivity of 33% to 90% and a specificity of 88% to 100%. Different immunoassays for CSF detection of antigens and/or antibodies have considerably varying degrees of sensitivity and specificity [31-33]. There has been a lot of study of TBM, but as a result, there aren't too many diagnostic tests for it. Due to the role of humoral and cell-mediated immunity in TBM infection, it has been hypothesized [34] that ADA and LDH activity in CSF and Serum aids in early diagnosis and helps to separate TBM from non-TBM infectious meningitis and non-infectious neurological disorders.

The adenosine deaminase enzyme of the purine salvage pathway catalyzes the adenosine and deoxyadenosine phosphorylase reaction, which converts adenosine and deoxyadenosine to inosine and deoxyinosine, respectively, while also releasing ammonia. It is critical for ADA to

be involved in both the proliferation and differentiation of T lymphocytes. Antibody against adenosine deaminase (ADA) is a powerful marker of cell-mediated immunity. In tuberculosis, an increased amount of ADA is generated when T-lymphocytes are stimulated by mycobacterial antigens. Multiple authors have reported that CSF-ADA has a high sensitivity and specificity for the diagnosis of extra pulmonary tuberculosis such as TBM [35].

There is a higher concentration of protein in the CSF of people with TBM because the number of protein-rich infection-fighting cells and protein-rich white blood cells is elevated. In most cases of bacterial meningitis, serum protein, particularly NANA-containing glycoproteins, is transported to the CSF, leading to a dramatic increase in CSF protein concentration. Protein levels are elevated in tuberculous meningitis compared to pyogenic infection because of the breakdown of the blood-brain barrier and the enhanced local production of gamma globulins. The sensitivity of culture can be diminished if antibiotics are administered prior to a lumbar puncture. The CSF volume needed to diagnose tuberculous meningitis is relatively high, between 4.0 and 5.0 ml. It can take up to six weeks for a culture to yield a conclusive result in a positive identification. The enzyme linked immunosorbent test (ELISA) has also been used to identify mycobacterial antigens. Recent advances in the field have led to the creation of a Lipoarabinomannan (LAM) antigen detection assay that outperforms previous methods. However, researchers have found that LAM - ELISA is not very sensitive.

The findings of this study imply that conventional methods of verifying a diagnosis of tuberculous meningitis, such as estimating the cell count, protein, and sugar levels in CSF, may be insufficient. Calculating adenosine deaminase levels could be a helpful indicator in making a conclusive diagnosis. It's possible that the activity of lactate dehydrogenase is a less specific metric than that of adenosine deaminase.

Conclusion

The investigation was conducted in the biochemistry, TB/chest, and general medicine departments. Study participants numbered 100. Pyogenic meningitis patients had greater CSF CRP levels than TBM and viral meningitis patients. Cases and controls had no association between CSF ADA, glucose, or protein levels. Combine CSF LDH and ADA to diagnose Tubercular meningitis early. This is important when gold standard meningitis tests, such as Smear and/or culture for AFB, are unavailable, negative, or time-consuming. These tests for ADA and LDH in Serum and CSF are straightforward and may be done in a central laboratory, minimizing unneeded or harmful therapy for patients. Appropriate sample size may be needed for future studies. SERUM & CSF ADA and LDH can diagnose Tubercular Meningitis early. History and clinical context should guide interpretation.

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