Serum Cholinesterase Level as a Biomarker in Detecting Liver Injury in Patients with Chronic Hepatitis C

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Background: hepatitis C virus can cause both acute and chronic hepatitis. The acute process is self-limited, rarely causes hepatic failure and usually leads to chronic infection. Chronic HCV infection often follows a progressive course over many years and can ultimately result in cirrhosis, HCC and the need for liver transplantation.
Objective: the aim of this study is to evaluate serum cholinesterase (CHE) level as a biomarker for detecting liver damage in patients with chronic hepatitis C.
Patients and Methods: the current study was carried out on 50 subjects selected from the outpatient's clinic of Internal Medicine Department of Sayed Galal Hospital, Al-Azhar University and admitted to the internal department. The study was performed in the period between July-2014 to July -2019.
Results: Sensitivity of cholinesterase is 100%, its specificity is 100% and its accuracy is 100%, in predicting liver injury in patients with chronic hepatitis C. Cholinesterase is positively correlated with Hb, platelets and albumin. Cholinesterase is negatively correlated with ALT, AST and ALP, total & direct bilirubin, PT, INR, urea, creatinine and AFP. There is significant increase of cholinesterase among compensated compared with decompensated cirrhotic patients**.** There is significant decrease of cholinesterase among compensated cirrhotic patients compared with controls**.** There is significant decrease of cholinesterase among decompensated cirrhotic patients compared with controls**.**
Conclusion: cholinesterase is an excellent biomarker of cirrhosis with good sensitivity and specificity**.** Cholinesterase shows good correlation with albumin, PT, INR and Child-Puch score. Cholinesterase distinguishes decompensated cirrhosis from compensated cirrhosis well**.**
Keywords: Cholinesterase, Liver, Hepatitis C virus

INTRODUCTION

Hepatitis **C** virus **(HCV)** can cause both acute and chronic hepatitis**.** The acute process is self-limited**,** rarely causes hepatic failure and usually leads to chronic infection**.** Chronic **HCV** infection often follows a progressive course over many years and can ultimately result in cirrhosis**,** hepatocellular carcinoma **(HCC)** and the need for liver transplantation **(1).**

Cirrhosis of the liver is a frequently encountered disease **(2).** Liver cirrhosis is a clinical condition wherein blemish tissue replaces normal tissue of the liver**.** As the healthy tissue is replaced by blotted tissue**,** there is an obstruction in the flow of blood through the liver affecting its function **(3).** Liver cirrhosis rarely causes signs and symptoms in its early stage**,** but as liver deteriorations the signs and symptoms appear **(4).**

Liver function tests (LFTs) that measures the level of serum liver enzymes usually reflects hepatocyte integrity or cholestasis rather than liver function **(5).**

Five laboratory assays are commonly called liver function tests **(serum alanine and aspartate transaminases, serum alkaline phosphatase, serum protein and albumin).** These tests are neither specific to the liver nor true measures of liver functions **(6).**

Cholinesterase is a family of enzymes that catalyze the hydrolysis of the neurotransmitter acetylcholine into choline and acetic acid **(3).**

There are 2 types; Acetyl cholinesterase also known as erythrocyte cholinesterase found in **RBCs** cell membrane and pseudo-cholinesterase known as plasma cholinesterase which is synthesized mainly in hepatocyte and is released into blood and its activity is reduced in liver dysfunction due to reduced synthesis **(7).**

In contrast to cholinesterase activity**,** the activities of the other serum enzymes associated with clinical assessment of liver function**,** increase due to excessive release from this cellular source after cell membrane damage **(3).**

In gastroenterology**,** the Child-Pugh score is used to assess the prognosis of chronic liver disease**,** mainly cirrhosis**.** Although originally used to predict mortality during surgery**,** this score is now used to determine the prognosis as well as the required strength of treatment and the necessity for liver transplantation **(8).**

However, the cirrhotic patients particularly those with Child-Pugh grades **B** and **C** with ascites or hemorrhagic tendency are usually treated with albumin or blood transfusion which may affect the numerical value for calculating the Child-Pugh score**.** The serum cholinesterase is not easily affected by this

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treatment [9]. The commonly available tests used in assessing the severity of cirrhosis have certain drawbacks. **However,** serum cholinesterase level in detecting liver damage in **chronic hepatitis C** needs to be clarified.

AIM OF THE WORK

The aim of this study is to evaluate serum cholinesterase level as a biomarker for detecting liver damage in patients with chronic hepatitis **C.**

SUBJECTS AND METHODS

(I) Subjects:

The current study was carried out on **50** subjects selected from the out patient's clinic of Internal Medicine Department of Sayed Galal Hospital, Al-Azhar University and admitted to the internal department. The study was performed in the period between July-**2014** to July **-2019.**

They were divided into:

Group 1: 20 Patients having compensated liver cirrhosis due to **HCV** infection.

G**roup 2: 20** Patients having decompensated liver cirrhosis due to **HCV** infection

G**roup 3: 10** Healthy subjects matched for age and sex as control group.

Exclusion criteria:

1-History of blood transfusion or albumin infusion **4** weeks prior to enrolment.
2-History and clinical evidence of variceal bleeding at enrolment.
3-History or evidence of **HCC**.
4-Liver transplantation.
5-Congenital liver disease.
6-Muscle dystrophy.
7-Pregnancy.

(II) Methods: The all subjects were subjected to the following:

(1) Full history taking.
(2) Clinical examination.
(3) Laboratory investigations.
(4) Fibro-Scan for assessment of degree of liver inflammation and fibrosis.
(5) AST platelet ratio index (APRI).

(6) Measurement of serum cholinesterase by DGKC method.

(7) Financial support: This work is not financially supported from any organization, society, institutes or government.

(9) Child-Turcotte-Pugh Score.

Ethical approval:

The study was approved by the ethics committee in Al-Azhar University Hospitals (El-Hussein and Sayed Galal) and a written informed consent was obtained from each person.

Statistical analysis of the data:

Data were fed to the computer and analyzed using **IBM SPSS** software package version **20.0. (Armonk, NY: IBM Corp)** Qualitative data were described using number and percent. The Kolmogorov-Smirnov test was used to verify the normality of distribution Quantitative data were described using range **(minimum and maximum),** mean, standard deviation and median. Significance of the obtained results was judged at the **5%** level.

The used tests were:

(1) - Chi-square test:
For categorical variables, to compare between different groups

(2) - Monte Carlo correction:
Correction for chi-square when **> 20%** of the cells has expected count **< 5**

(3) - F-test (ANOVA):
For normally distributed quantitative variables, to compare between more than two groups, and Post Hoc test **(Tukey)** for pairwise comparisons

(4) - Pearson correlation coefficient:
It is a measure of the strength of the linear relationship between **2** variables. It is referred to as Pearson's correlation or simply as the correlation coefficient. Positive correlation indicates that both variables increase or decrease together, whereas negative correlation indicates that as one variable increases, so the other decreases and vice versa.

(5) - Mann Whitney test:
For abnormally distributed quantitative variables, to compare between **2** studied groups

(6) - Kruskal Wallis test:
For abnormally distributed quantitative variables, to compare between more than **2** studied groups and Post Hoc **(Dunn's multiple comparisons test)** for pairwise comparisons

(7) - Receiver operating characteristic curve (ROC):
It is generated by plotting sensitivity **(TP)** on **Y** axis versus **1**-specificity **(FP)** on **X** axis at different cut off values. The area under the **ROC** curve denotes the diagnostic performance of the test. Area > **50%** gives acceptable performance and area about **100%** is the best performance for the test. The **ROC** curve allows also a comparison of performance between **2** tests.

(8) - Sensitivity:
The capacity of the test to correctly identify diseased individuals in a population **'TRUE POSITIVES'**, the greater the sensitivity, the smaller the number of unidentified case **'false negatives'**

(9) - Specificity:
The capacity of the test to correctly exclude individuals who are free of the disease **'TRUE NEGATIVES'**, the greater the specificity, the fewer **'false positives'** will be included

(10) - Positive Predictive value (PPV):

The probability of the disease being present, among those with positive diagnostic test results

(11) - Negative Predictive value (NPV):

The probability that the disease was absent**,** among those whose diagnostic test results were negative

- **Insignificant: if P- value > 0.05**
- **Significant: if P- value ≤ 0.05**

RESULTS

The current study included 50 subjects; they were divided into:

- **Group (1): 20** Patients had **compensated cirrhosis** due to **HCV** infection
- **Group (2): 20** Patients had **decompensated cirrhosis** due to **HCV** infection
- **Group (3): 10 Healthy subjects** matched for age and sex as controls

Table (1): Comparison between the studied groups according to sex and age:

Parameters		Group 1 (n = 20)		Group 2 (n = 20)		Group 3 (n = 10)		Test of Sig.	p
		No.	%	No.	%	No.	%		
Sex	Male	16	80.0	16	80.0	9	90.0	χ^2 = 0.504	^{MC}P= 0.804
	Female	4	20.0	4	20.0	1	10.0		
Age (years)	M ± SD.	48.80 ± 4.06		50.70 ± 4.14		47.10 ± 4.75		F = 2.575	0.087
	Median	48.50		49.50		45.0			

χ^2: Chi square test MC: Monte Carlo F: F for ANOVA test

- **There are insignificant differences between the studied groups as regards sex and age.**

Table (2): Comparison between the studied groups according to risk factors:

	Group 1(n= 20)		Group 2 (n= 20)		Group 3 (n= 10)		χ^2	p
	No.	%	No.	%	No.	%		
Alcohol drinking	0	0.0	0	0.0	0	0.0	–	–
Smoking	5	25.0	4	20.0	4	40.0	1.403	0.496
DM	4	20.0	4	20.0	0	0.0	2.216	^{MC}P= 0.325
HTN	3	15.0	1	5.0	0	0.0	1.786	^{MC}P= 0.518
Blood transfusion	0	0.0	0	0.0	0	0.0	–	–
IV. Albumin	0	0.0	0	0.0	0	0.0	–	–

χ^2: Chi square test MC: Monte Carlo

- **There are insignificant differences between the studied groups as regards these risk factors.**

Table (3): Comparison between group-1 and group-2 according to HCV-PCR:

HCV-PCR (IU/mL)	Group 1 (n = 20)	Group 2 (n = 20)	U	P
M ± SD.	716907.0 ±162284.54	516053.0 ± 116688.3	192.0	0.841
Median	361939.0	498686.0		

U: Mann Whitney test

- **There is insignificant difference between group-1 and group-2 as regards HCV-PCR.**

Table (4): Comparison between the studied groups according to different parameters:

Parameters	Group 1 (n = 20)		Group 2 (n = 20)		Group 3 (n = 10)		χ^2	p
	No.	%	No.	%	No.	%		
HCV infection	20	100.0	20	100.0	0	0.0	41.713*	^{MC}P < 0.001*
Ascites	0	0.0	20	100.0	0	0.0	50.000*	< 0.001*
Edema	0	0.0	20	100.0	0	0.0	50.000*	< 0.001*
HE	0	0.0	9	45.0	0	0.0	14.989*	^{MC}P < 0.001*
Liver cirrhosis	20	100.0	20	100.0	0	0.0	41.713*	^{MC}P < 0.001*
Splenomegaly	15	75.0	20	100.0	0	0.0	32.143*	< 0.001*

χ^2: Chi square test MC: Monte Carlo

Table (5): Comparison between the studied groups according to CBC:

CBC		Group 1 (n = 20)	Group 2 (n = 20)	Group 3 (n = 10)	F	P
WBCs	M ± SD.	5125.0 ± 1060.7	4385.0 ± 950.5	7790.0 ± 1342.0	33.979*	< 0.001*
	Median	5200.0	4250.0	7650.0		
	Sig.bet.groups	P_1= 0.087, P_2 < 0.001*, P_3 < 0.001*				
Hb	M ± SD.	11.06 ± 1.44	9.24 ± 0.73	13.02 ± 0.85	41.656*	< 0.001*
	Median	10.75	9.25	12.85		
	Sig.bet.groups	P_1 < 0.001*, P_2 <0.001*, P_3 < 0.001*				
Plat.	M ± SD.	139.56 ± 31.76	89.40 ± 5.37	227.60 ± 32.71	73.047*	< 0.001*
	Median	141.0	87.50	227.0		
	Sig.bet.groups	P_1 < 0.001*, P_2 < 0.001*, P_3 < 0.001*				

F: F for ANOVA test, Pairwise comparison between each 2 groups was done using Post Hoc Test (Tukey)
P_1: P value for comparing between group 1 and group 2 , P_2: P value for comparing between group 1 and group 3
P_3: P value for comparing between group 2 and group 3

- There is insignificant decrease of WBCs among group 2 compared with group 1
- There is significant decrease of WBCs, Hb and platelets among group 1 compared with group 3
- There is significant decrease of WBCs, Hb and platelets among group 2 compared with group 3
- There is significant increase of Hb and platelets among group 1 compared with group 2

Table (6): Comparison between the studied groups according to AST, ALT, ALP, albumin and PT:

Liver function		Group 1 (n = 20)	Group 2 (n = 20)	Group 3 (n = 10)	Test of sig.	P
AST (U/L)	M ± SD.	50.20 ± 10.95	48.85 ± 3.10	31.60 ± 4.45	F = 10.642*	< 0.001*
	Median	48.0	46.0	32.0		
	Sig.bet.grps	P_1 = 0.921, P_2 < 0.001*, P_3 = 0.001*				
ALT (U/L)	M ± SD.	42.20 ± 10.16	43.05 ± 10.09	23.20 ± 5.87	H = 19.073*	< 0.001*
	Median	37.0	42.50	21.50		
	Sig.bet.grps	P_1 = 0.672, P_2 < 0.001*, P_3 < 0.001*				
ALP (U/L)	M ± SD.	145.3 ± 28.35	146.0 ± 23.07	74.70 ± 10.17	F = 35.912*	< 0.001*
	Median	143.0	144.0	71.50		
	Sig.bet.grps	P_1 = 0.995, P_2 < 0.001*, P_3 < 0.001*				
Albumin (g/dL)	M ± SD.	3.68 ± 0.18	2.85 ± 0.13	4.27 ± 0.35	F = 173.507*	< 0.001*
	Median	3.60	2.90	4.18		
	Sig.bet.grps	P_1 < 0.001*, P_2 < 0.001*, P_3 < 0.001*				
PT	M ± SD.	13.30 ± 1.46	19.14 ± 1.84	11.82 ± 0.53	F = 108.404*	< 0.001*
	Median	13.35	19.05	11.80		
	Sig.bet.grps	P_1 < 0.001*, P_2 < 0.001*, P_3 < 0.001*				

F: F for ANOVA test, Pairwise comparison between each 2 groups was done using Post Hoc Test (Tukey)
H: H for Kruskal Wallis test, Pairwise comparison between each 2 groups was done using Post Hoc Test (Dunn's for multiple comparisons test), P_1: P value for comparing between group 1 and group 2, P_2: P value for comparing between group 1 and group 3, P_3: P value for comparing between group 2 and group 3

Table (7): Comparison between the studied groups according to T. bilirubin and D. bilirubin:

Parameters		Group 1 (n = 20)	Group 2 (n = 20)	Group 3 (n = 10)	F	p
T.bilirubin (mg/dl)	M ± SD.	1.34 ± 0.25	3.03 ± 0.93	0.84 ± 0.14	56.509*	< 0.001*
	Median	1.30	3.15	0.85		
	Sig.bet.grps	P_1< 0.001*, P_2 = 0.104, P_3 < 0.001*				
D. bilirubin (mg/dl)	M ± SD.	0.57 ± 0.07	1.66 ± 0.23	0.16 ± 0.07	52.928*	< 0.001*
	Median	0.60	1.50	0.14		
	Sig.bet.grps	P_1< 0.001*, P_2 = 0.045*, P_3 < 0.001*				

F: F for ANOVA test, Pairwise comparison between each 2 groups was done using Post Hoc Test (Tukey)
P_1: P value for comparing between group 1 and group 2, P_2: P value for comparing between group 1 and group 3
P_3: P value for comparing between group 2 and group 3

Table (8): Comparison between the studied groups according to INR and AFP:

Parameters		Group 1 (n = 20)	Group 2 (n = 20)	Group 3 (n = 10)	Test of sig.	P
INR	M ± SD.	1.22 ± 0.18	1.70 ± 0.18	1.04 ± 0.08	F = 66.746*	< 0.001*
	Median	1.25	1.71	1.05		
	Sig.bet.Grps	$P_1 < 0.001^*$, $P_2 = 0.017^*$, $P_3 < 0.001^*$				
AFP (ng/ml)	M ± SD.	5.61 ± 1.09	9.23 ± 1.12	2.57 ± 0.84	H = 25.356*	< 0.001*
	Median	4.45	7.10	2.55		
	Sig.bet.Grps	$P_1 = 0.023^*$, $P_2 = 0.002^*$, $P_3 < 0.001^*$				

F: F for ANOVA test, Pairwise comparison between each 2 groups was done using Post Hoc Test (Tukey)

H: H for Kruskal Wallis test, Pairwise comparison between each 2 groups was done using Post Hoc Test (Dunn's for multiple comparisons test), P_1: P value for comparing between group 1 and group 2, P_2: P value for comparing between group 1 and group 3, P_3: P value for comparing between group 2 and group 3

Table (9): Comparison between group-1 and group-2 according to serum cholinesterase results:

Cholinesterase (IU/L)	Group 1 (n = 20)	Group 2 (n = 20)	Group 3 (n = 10)	F	p
Range	3194.3 - 3798.2	1642.7 - 2725.2	6214.0 - 9182.0	317.587*	< 0.001*
M ± SD	3437.6 ± 173.5	2209.2 ± 367.3	7683.94 ± 1153.10		
Median	3416.1	2255.6	7680.23		
Sig.bet.Grps	$P_1 < 0.001^*$, $P_2 < 0.001^*$, $P_3 < 0.001^*$				

F: F for ANOVA test, Pairwise comparison between each 2 groups was done using Post Hoc Test (Tukey)

P_1: P value for comparing between group 1 and group 2

P_2: P value for comparing between group 1 and group 3

P_3: P value for comparing between group 2 and group 3

- **There is significant increase of cholinesterase among group 1 compared with group 2**
- **There is significant decrease of cholinesterase among group 1 compared with group 3**
- **There is significant decrease of cholinesterase among group 2 compared with group 3**

Table (10): ROC curve for different parameters to diagnose cirrhotics from controls

Parameters	AUC	P	95 %CI	Cutt off	Sensitivity	Specificity	PPV	NPV
Cholinesterase	1.000	< 0.001*	1.0 - 1.0	≤ 3798.24	100.0	100.0	100.0	100.0
APRI	0.999	< 0.001*	0.93 - 1.0	> 0.5	97.50	100.0	100.0	90.9

AUC: Area under curve P value: Probability value CI: Confidence Intervals
NPV: Negative predictive value PPV: Positive predictive value

Table (11): ROC curve for different parameters to diagnose of compensated from decompensated cirrhotcis

Parameters	AUC	P	95 %CI	Cutt off	Sensitivity	Specificity	PPV	NPV
Cholinesterase	1.000	< 0.001*	1.0 - 1.0	> 2725.23	100.0	100.0	100.0	100.0
APRI	0.810	< 0.001*	0.66 - 0.92	≤ 1.2	90.0	65.0	72.0	86.7

AUC: Area under curve P value: Probability value CI: Confidence Intervals
NPV: Negative predictive value PPV: Positive predictive value

DISCUSSION

The aim of the current study is to evaluate serum **CHE** level as a biomarker for detecting liver injury in patients with **CHC.** For this purpose**; 50 subjects (20 patients had compensated cirrhosis, 20 patients had decompensated cirrhosis and 10 healthy persons as controls) were selected.**

All the studied subjects were subjected to full history taking**,** throughout clinical examination**,** laboratory investigations including**; CBC, AST, ALT,** serum total and direct bilirubin**,** serum albumin**, ALP, PT** and **INR,** urea and creatinine**, AFP, HCV-**antibodies and **HVC-RNA** by **PCR** and measurement of serum cholinesterase**,** liver fibroscan and **APRI** test**.**

The mean age of controls is **47 years old** which is not significantly different from the other studied groups**.** Male sex was representing the majority in all groups**.**

In this study **HCV-RNA** level is lower in patients with end-stage **HCV-**related liver cirrhosis than compensated cirrhosis and this is matched with study done by **Duvoux *et al.*** [10]**.**

In the present study serum **albumin** level is significantly lower in decompensated patients more than compensated patients as compared with controls**.** Also, **PT** is prolonged in decompensated more than compensated cirrhotic patients also as compared with controls**.**

Serum **bilirubin** level show statistically significance increase among decompensated cirrotic patients compared with either compensated cirrhptic patients or controls**.**

In this work there is a significant negative correlation between serum cholinesterase levels and **ALT, AST, ALP, PT, INR,** bilirubin and **AFP** levels respectively**,** while there is a positive correlation between serum cholinesterase and serum albumin level**.**

AFP level increased significantly in compensated and decompensated groups as compared to controls and this agree with the study done by **Chu *et al.*** [11] who found that the severity of fibrosis/cirrhosis was significant predictors of elevated serum **AFP** and that higher serum **AFP** levels were significantly correlated with advanced fibrosis /cirrhosis in patients with chronic **HCV.**

In the current study **APRI < 0.5** identified healthy controls from compensated cirrhosis with sensitivity of **APRI** is **97.5**% and its specificity is **100**% and **APRI ≤ 1.2** can identified compensated cirrhotics from decompensated cirrhotics with sensitivity of **APRI** is **90%** and its specificity is **65%.** But many conditions lead to elevated of liver transaminases that infelunce estimation of **APRI** score**; for example,** thyroid disorders and celiac sprue have been associated with elevated transaminase levels [12]**.** Hemolysis and strenuous exercise should be considered also [13]**.**

In the present study cirrhotics are found to have significantly lower levels of serum **CHE** compared with the controls and the lower levels were correlated with Child Score such patients**.** These results were matched with those obtained by **Meng *et al.*** [9] who found serum **CHE** were low in various Child-Pugh score groups**.** The cirrhotic patients were strictly grouped into the **A, B** and **C** groups**,** based on their Child-Pugh score**.** The results showed that serum **CHE** tended to decrease significantly in the **3** grades**: Child A (5368.04 ± 1657.32 U/l), Child B (2943.06 ± 1212.84 U/l) and Child C (1832.51 ± 710.68 U/l).** Difference between **CHE** activity in the **Child A, B** and **C** groups was statistically significant**,** as was the difference between the mean values for the **Child B** and **C** groups**.**

In the current study patients with liver cirrhosis have significantly lower levels of serum **CHE** compared with the controls and the lower levels were correlated with Child-Pugh Score such patients**.**

Similarly**, Amany *et al.*** [14] found highly significant decrease in serum **CHE** levels in decompensated patients compared with compensated patien and serum **CHE** level at **≤ 4210 u/l (cutoff)** can diagnose compensated cirrhosis by **86.67%** sensitivity**, 100%** specificity**, 100% PPV** and **88.24% NPV,** while**,** seum **CHE** serum at **≤ 2152 u/l (cutoff)** can diagnose decompensated cirrhosis by **93.33%** sensitivity**, 100%** specificity**, 100% PPV** and **93.75% NPV**.

In this study**,** the mean serum **CHE was 3437.6 ± 173.5 IU/L** in compensated cirrhotic patients**, 2209.2 ± 367.3** in decompensated cirrhotic patients and **was 7683.94 ± 1153.10** in controls**.**

This is in agreement with a study conducted by **Ramachandran *et al.*** [15] who found the median serum **CHE** level in cirrhotics was **1595 IU/L (110 - 8143)** compared with **7892 (2022 - 21673)** in controls and the median level of compensated cirrhotic patients **was 4246 (680 - 8143)** compared with **7892 (2022- 21673)** in controls and also found the median level in decompensated cirrhotic patients was **1324 (110 - 4550)** compared with compensated cirrhotic patients was **4246 (680 - 8143)** and found that serum **CHE** levels below **3506** had a **98.7%** sensitivity and **80.3%** specificity in predicting cirrhosis. They concluded that serum **CHE** is an excellent biomarker of cirrhosis with good sensitivity and specificity**.**

Varsha [16] made a study on serum **CHE** as important diagnostic marker to distinguish between liver diseases **(hepatits, cirrhosis, obstructive jaundice, liver abcess and liver mass)** and non-liver diseases **(dermatitis, acute respiratory failure, cellulitis, bone diseases, renal failure, anasrca and COPD)** and they found that serum **CHE** levels were decreased in liver disease patients only**,** as compared with levels of conventional liver function tests which are decreased in both group of patients thereby showing that serum **CHE** assay has much more significance to diagnose liver disease patients**.**

Thus it can be stated that serum **CHE** alone can be very helpful to distinguish liver diseases from non-liver disease**.** It is **94.7%** sensitive and **100%** specific**,** thereby suggesting that serum **CHE** activity strongly indicate liver dysfunctions**.**

In the current study**;** the cut off value to diagnose compensated cirrhosis from controls is **≤ 3798.24 U/l** and the cut off value to diagnose decompensated cirrhosis from compensated cirrhosis **< 2725.23** with **100%** sensitivity and **100%** specificity**;** while **Ramachandran *et al.*** [15] found that **CHE** level was **< 2385 IU/L** had **80.1%** sensitivity and **88.2%** specificity in predicting decompensated cirrhosis**.**

In this study it is found that the cirrhotics have significantly lower levels of serum **CHE** as compared with healthy controls**.** Also it is found that patients with decompensated cirrhosis have significantly lower levels compared with compensated cirrhosis**.**

Serum levels of **CHE** showed excellent positive correlation with serum albumin levels in the current study**.** These results were matched with those concluded by **Mohamed *et al.* [3]. Moreover,** serum level of **CHE** is negatively correlated with **PT,** which is in agreement with the study done by **Mohamed *et al.* [3].**

CONCLUSION

- There is association between cholinesterase and liver disorders, viral hepatitis and liver cirrhosis.
- Cholinesterase can be used as a routine diagnostic test besides other liver function tests for investigation of liver disorders.
- Cholinesterase is an excellent biomarker of cirrhosis with good sensitivity and specificity.
- Cholinesterase shows good correlation with albumin, PT, INR and Child-Puch score.
- Cholinesterase distinguishes decompensated cirrhosis from compensated cirrhosis well.
- Low levels of cholinesterase in cirrhosis may serve as a useful prognostic marker of advanced liver disease.
- The level of cholinesterase is closely correlated with the severity of liver damage and correlated also with the Child-Pugh score.
- Combination of cholinesterase with Child-Pugh score may be more objective and accurate in evaluating the liver reserve function of cirrhotic patients.
- Cholinesterase level reflects liver cell conditions; where low levels indicate hepatocellular damage.

RECOMMENDATION

- Long-term follow-up studies are warranted to define cholinesterase exact role in clinical practice**.**

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