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THE EFFECT OF STARVATION ON BLOOD PARAMETERS, ELECTROLYTES AND LIVER ENZYMES IN ALBINO RATS

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Abstract

The diagnosing of liver disease depends upon a combination of histology, physical examination, laboratory testing sometime radiological studies and biopsy. To correlate the effect of starvation which either lead to increase or decrease in serum level or help in differentiating its effect with

other liver diseases. The effect of Starvation on blood parameters, electrolytes and Liver enzymes were determined in apparently healthy normal albino rats of Wister strain. Thirty albino rats were used and were divided into five groups of SIX rats each. Blood glucose showed significant decreased in serum level, which was highly significant ($p<0.001$) at 72hours starvation. Albumin also showed significant decrease but regained normal level at 72hours starvation. The transaminases (Alat and Asat) and alkaline phosphatase showed significant increase while acid phosphatase showed decrease as duration of starvation increased for 72hours. The chief intercellular cation (K^+) initially became decreased but with prolonged starvation up to 72hours, there were significant increase ($p<0.05$). The liver therefore shows functional alteration with time following starvation.

Key words: *Starvation, Blood parameter, Liver, Serum level, Glucose, Transaminases*

INTRODUCTION

Starvation is a very serious form of malnutrition characterized by a deficiency in nutrients, vitamins and caloric intake. Starvation may result from famine, anorexic nervosa, and catastrophic diseases of gastro intestinal tract, stroke or coma. People experience starvation as a result of food deprivation or because of diseases which cause disorders of metabolism that interfere with the ability to absorb nutrients (Merck, 2002). The basic metabolic response to starvation is conservation of energy and body tissues. However, the body will mobilize its own tissues as a source of energy which results in the destruction of visceral organ and muscles and extreme shrinkage of adipose tissues. The starved fed cycle is characterized into three stages:-

(i) The well fed or post absorptive state
(ii) The early fasting stage
(iii) The refed state after

A major goal of the many biochemical alternation in this period is to maintain glucose homeostasis. The well fed or post absorptive state, lead to the secretion of insulin by theβ-cells of the pancreases, stimulated by glucose and parasympathetic nervous system. Therefore, insulin signals the fed stage. The high insulin level in the fed stage also promotes the entry of glucose into muscle and adipose tissue there by stimulating the synthesis of glycogen by muscles as well as the liver. The early fasting state is characterized by a decrease in insulin secretion and a rise in glucagon secretions by drop in blood-glucose level several hours after a meal. Glucagon is secreted by the α-cells of the pancreases in response to a low-blood-sugar level in the fasting state. It serves to mobilize glycogen stores when there is no dietary intake of glucose. Glucagon therefore signals the fast-state.

The refed state has same processed pathways for fat as in the normal fed state. However, it is not so in the case of glucose. The liver does not initially absorbe glucose from the blood but rather leaves it for peripheral tissue and there by remain in a gluconeogenic mode (Berg *etal.*, 2002). Even under starvation condition, the blood glucose must be maintained above 2.2mm/l (40mg/dl). The first priority of metabolism is to provide sufficient glucose to the brain and other tissues (such as the blood cells) that are absolutely dependent on this fuel. So understanding the changes on blood parameters as a result of starvation will make an easy

and effective way in differentiating in diagnosing and treatment of some other liver diseases. This work is designed to study the changes on some biochemical parameters resulting from starvation and after starvation on re-fed animal the same hours of starvation. Attempt was made to correlate the parameters observed in the starved and re-fed animals.

MATERIALS AND METHODS

Source of Animals

Thirty adult albino rats(western strain) were obtained from the Biochemistry Research Laboratory Animal House, Department of Biochemistry, College of Medical Sciences, University of Maiduguri.

EXPERIMENTALPROCEDURE

The thirty adult albino rats (western strain) were weighed (105.4gto209.61g).They were acclimatized and quarantined under standard laboratory condition for one month and had free access to grower mesh feeds (*Ecw*a feed and feed master Nig Ltd. Maiduguri) and clean water was served in feeding bottles to the animals.

The animal were randomly selected and divided into five groups of six rats per cage. One group of animal that served as control had free access to food and water throughout the experiment (fed animal). Groups II-V served as the experimental animals (starved animals). Groups II to V were subdivided into two groups of 3 rats and each subdivision was starved for 12, 24, 48 and 72 hours respectively. One of the subdivision after starvation, they were later refed for the same hours of starvation. Each animal weight was taken and recorded before and after starvation and also after refed before they were sacrificed by cervical dislocation.

After starvation, the animals were sacrificed through cervical dislocation. Their bloods were collected and plasma separated through centrifugation at 5000*rpm* for 15 minutes. Thereafter, the plasma serum was then sent to the Department of Chemical Pathology, University of Maiduguri Teaching Hospital for assay of blood glucose, cholesterol, total protein, albumin, urea, creatinine, transaminases (Asat and Alat) and serum electrolytes (Na^+, K^+, Cl^-, Hco_3 and Po_4^{3-}).

RESULT

Table 1:**EFFECT OF STARVATION ON WEIGHT OF ANIMALS (MEAN±SD)**

	12 hrs		**24 hrs**		**48 hrs**		**72 hrs**	
BEFORE STARVATION	196±18.14	177.4±16.61	181.1±6.02	171.9±11.33	164.1±10.95	157.1±1.72	170.8±9.90	162.8±3.26
AFTER STARVATION	193.4±19.17	174.7±15.56	166.0±4.64**	154.6±9.21	149.6±7.79	142.1±1.57	148.1±9.37**	140.7±4.41
REFED AFTER STARVATION		183.6±19.69*		170.7±9.46		161.7±4.29*		159.7±3.58

*significant p<o.o1, ** p<o.oo1

In table 1, there was increase in weight losts as starvation proceeds. Weight loss ≤ 20g. At 72 hours Weight loss ≤ 22g refed. 12 hours and 48 hours refed animas showed additional increase of +4g respectively while 24 and 72hours starvation, there was reduction of -1g and -3g respectively. There was a significant of ($p<0.01$) on refed and ($p<0.001$) after starvation.

Table 2: EFFECT OF STARVATION ON LIVER ENZYME

ENZYME (IU)	CONTROL	12 hrs		24 hrs		48 hrs		72 hrs	
		Staved	Refed	Starved	Refed	Starved	Refed	Starved	Refed
Asat	249	245.0±72.8	287.7±31.79	204±28.16	268.3±137.76	187±15.05	217.7±82.80	363.7±79.84*	248±36.51
Alat	65.7	71±2.65	80±12.12	58.3±31.89	127.7±25.81**	65.3±24.00	101±25.16	102±29.46*	66.7±2.89
Alkaline phosphatase	103.0	197.3±61.19*	262.7±66.06**	85±29.51	244±90.62**	100.7±30.09	224.3±66.50*	583±2.08	114±25.94
Acid phosphatase	2 3	7.7±3.21	12±3.61	23±2.65	27±4.36	7.3±3.21	15.7±3.79	8±2.65	15.7±2.52

*p<0.05, **p<0.01,***p<0.001

There was significant increase in both transaminases at 72hrs starved. Restoration is seen at 72hrs refed on the liver specific enzyme (Alat). Alkaline phosphatese showed significant in 12, 24, and 72hrs.

There was significant increase in both transaminases with a significant of ($p<0.05$)as shown in Table 2 at 72 hours starvation. Restoration is seen at 72hrs refed in both transaminases (ALAT and ASAT). Alkaline phosphatase showed significant of ($p<0.05$) at 12, 24, and 48 hours refed respectively

Table3: EFFECT OF STARVATION ON BIOCHEMICAL PARAMETERS (MEAN ± S)

Biochemical parameters	Control	12 hrs		24 hrs		48 hrs		72 hrs	
		Staved	Refed	Staved	Refed	Staved	Refed	Staved	Refed
Blood glucose	6.65	62±1.08	62±1.0	5.4±0.50	6.7±1.09	3.8±1.01**	3.4±2.17*	2.9±2.17***	5.6±0.1
Cholesterol	2.85	2.8±0.12	2.4±0.15	2.5±0.12	2.3±0.15*	2.8±0.40	3.4±0.23*	3.0±0.30	3.1±0.4
Total protein	72.65	78.7±8.0	66.3±2.31	69±2.00	63±5.57	69±27.62	71±4.36	8.43±7.51	63.7±4.5
Albumin	38.00	35±3.61	34.7±2.52	33±1.73*	33.3±0.57*	28.7±6.81*	38.7±1.15	36.7±1.53	42.3±1.5*
Urea	8.80	6.5±0.62	6.5±1.94	5.8±0.97	6.8±0.72	6.9±1.78	3±0.53*	5.9±0.59	26.1±29.3
Cretimine	106.80	116±0.00**	123±10.02**	116±0.00**	126.7±4.16	116±0.00**	126±7.23***	126.3±6.51***	114.0±1.7*

*=p<0.05,**=p<0.001,***=p<0.001

The blood glucose showed significant decrease at both 48hours starvation and refed respectively. There has been a significant ($p<0.05$) decrease at 72hours of starvation. At 72 hours refed, serum blood glucose level became normal, 12 hours starvation and refed showed increase in blood glucose level of about 0.55mmoles. Serum cholesterol level showed significant ($p<0.05$) increase at 48 and 24 hours refed.

Albumin showed significant ($p<0.05$) decrease at 12, 24 and 48hours starvation period but was almost restored to normal level at 72 hours of starvation. There was a significant ($p<0.05$) increase at 72 hours of starvation.

A decrease was observed in Serum Urea but was not significant. Creatinine level remained constant at 12, 24 and 48 hours of starvation, but increase significantly ($p<0.001$) at 72hours of starvation.

Table4: EFFECT OF STRAVATION ON SERUM ELECTROLYTE

Serum electrolyte	Control	12 hrs		24 hrs		48 hrs		72 hrs	
		Staved	Refed	Staved	Refed	Staved	Refed	Staved	Refed
Na^+	138.8	138.7±3.06	140.7±3.06	138.7±2.31	139±2.31	138.7±1.53	137±1.73	139±1.0	138.7±1.53
K^+	6.1	5.7±0.62	51±0.06*	4.9±0.36	4.8±0.38***	7±0.00***	6.7±0.29*	6.5±0.50	6.4±0.06
Cl^-	100	102±2.0	106±2.0	102.7±1.15	104±5.29	104.7±2.31	102±2.00	104±2.00	101.3±1.15
Hco_3^-	19.35	20.3±0.58	20±2.00	20±0.00	20±0.00	20±0.00	19.3±1.15	17±0.00**	17.7±0.58
Total calcium	2.70	2.6±0.1	24±0.17	2.5±0.00	2.7±0.1	2.8±0.26	2.6±0.1	2.4±0.00	2.2±0.15*
Po_4^{3-}	1.50	0.9±0.21	1.2±0.06	1.6±0.35	1.7±0.25	1.7±0.20	2.3±0.17	1.6±0.35	1.6±0.35

*=p<0.05, **=p<0.01, ***=p<0.001

Effect of Starvation on Serum Electrolytes

Serum K^+ was initially low as duration of starvation increased from 12 to 24 hours. However, with prolonged starvation at 48 to 72 hours, there was a significant ($p<0.001$), ($p<0.05$) increase in level of K^+ respectively.

Animal refed for 12, 24 and 48 hours showed significant ($p<0.05$), ($p<0.001$) and ($p<0.005$) decrease in K^+ level respectively.

Serum HCO_3^- showed significant ($p<0.01$) at 72 hours starvation. Total calcium also showed significant ($p<0.05$) increase in Ca^{2+} level while Serum Na^+, Cl^- and PO_4^{3-} level were not significantly different from control value.

DISCUSSION

In this study, the liver which does most of the metabolic activities in the body is under stress as the duration of starvation increased. The loss of weight observed and it decreases as starvation progress which may be attributed to the depletion in the concentration of glycogen from it stores, (liver and muscle) and decrease in muscles protein. However,Li *etal*1979, Hirose *etal*1986, and Garlick *etal*1975 reported that the amount of muscles protein decreases during starvation.

Biochemical Analysis

Aminotransaminases are enzymes of both cytoplasm and mitochondria. Normal plasma contain low activities of alanin and aspartate transaminases, the source of which is unknown (frinlayson and Bouchier, 1995). Adaptive changes following cell damage are mainly cytoplasmic and are related to increased or altered metabolic function (Ghadially, 1975). The marked increased in serum level of both transaminases may indicate liver hyper function in response to over activities in trying to meet the conversion step of glycogen breakdown to released glucose into the blood stream. Although aspartate transaminases showed a higher

serum level than the Alat. The Heart is also sites for the production, which could also be elevated in other condition unlike the Alat, which is only specific for the liver.
Decrease in blood glucose as duration of starvation progressed clearly significant how the body mobilized it own tissue as source of energy that result in the destruction of visceral organ (Merck, 2002). Released of glucose into blood is achieved when dietary intake is short down causing workload to the liver and muscles to released glucose.

An elevated serum cholesterol concentration has been implicated as one of the several risk factors in cardiovascular disease such as arteriosclerosis and myocardial infarction (Alex *etal*., 1988) it has also been documented that an increase in cholesterol level increase the risk of portal hypertension because cholesterol is mainly absorbed in the small intestine.
The significant decrease of albumin at start of starvation and regained normal level at 72hours is in agreement with finding of Merck (2002) that "serum albumin is near normal as long as muscles in broken down to provide amino acid for protein synthesis in the liver".
Albumin level can be low in conditions other than liver disease including malnutrition (Worman, 1999). Starvation in a more severe form of malnutrition.

Concentration of serum creative may be as a result of increased workload to the muscle as glycogen is broken down to release glucose. Serum creatinine rises only when formation or excretion of urine is in pared irrespective of whether it is pre-renal, renal or post renal in origin (Alex *etal.,* 1988).
Electrolytes play a major role in acid-base balance in the body. Increase in H+ or Cl^- ion results in alkalosis. Na^+ is the Chief extracellular ion while the major intracellular ion is K^+.
The elevation of serum K^+ normally result from the released of K^+ from dead or majored cells arising from the tissues damage, haemolysis and gastrointestinal bleeding among others (Cumming and Swainson, 1995).
The effect of starvation on both blood parameter, transaminases and electrolytes is time dependent. Some blood parameters are altered causing metabolic and structural alteration in the hepatohistomorphology of the rat liver.

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