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Original Research Article

A COMPARATIVE PROSPECTIVE STUDY OF LIPID PROFILE AND LIVER ULTRASONOGRAPHY IN CHILDREN WITH SEVERE ACUTE MALNUTRITION AND HEALTHY CHILDREN (AGE 6 MONTHS TO <5 YEAR) AT J.L.N MEDICAL COLLEGE, AJMER

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ABSTRACT

Background: Severe acute malnutrition (SAM) in children under five is associated with metabolic disturbances, impaired immunity, growth failure and altered lipid metabolism. Although hepatic steatosis is more common in edematous malnutrition, it may also occur in non-edematous SAM. This study assessed lipid profile abnormalities and liver ultrasonographic changes in children with SAM before and after nutritional rehabilitation.

Materials and Methods: This prospective observational study included 100 children with SAM and 100 age-matched healthy controls (6 months to <5 years) at the Malnutrition Treatment Centre, Jawaharlal Nehru Medical College, Ajmer, Rajasthan. Clinical evaluation, anthropometry, serum lipid profile (total cholesterol, triglycerides, HDL-C, LDL-C and VLDL-C) and liver ultrasonography were performed at baseline. Children with SAM were reassessed after 2 months of nutritional rehabilitation.

Results: Children with SAM had significantly lower lipid parameters than controls at admission. Following rehabilitation, total cholesterol (102.16±29.68 to 168.16±28.18 mg/dL), triglycerides (79.72±37.17 to 99.83±32.08 mg/dL) and HDL-C (38.78±13.82 to 50.41±9.62 mg/dL) increased significantly ($p<0.05$), whereas LDL-C and VLDL-C showed non-significant improvement. Hepatic steatosis was detected in 94% of SAM children (Grade I: 35%, Grade II: 57%, Grade III: 2%), involving both edematous and non-edematous SAM. After rehabilitation, Grade II and III steatosis resolved completely.

Conclusion: SAM is associated with dyslipidemia and a high prevalence of hepatic steatosis irrespective of edema. Nutritional rehabilitation significantly improves lipid abnormalities and hepatic steatosis, supporting lipid profiling and liver ultrasonography as useful tools for assessment and follow-up.

Keywords: Hepatic steatosis, Lipid profile, Liver ultrasonography, Severe acute malnutrition.

INTRODUCTION

Severe acute malnutrition (SAM) is a major cause of morbidity and mortality in children under five years of age, leading to impaired growth, immune dysfunction, metabolic derangements and multi-organ involvement.[1,2] The liver is particularly affected due to protein-energy deficiency, resulting in altered lipid metabolism, reduced lipoprotein synthesis and impaired hepatic fat transport. Consequently, children with SAM frequently exhibit abnormalities in serum lipid profile and hepatic steatosis.[3]

Serum lipid profile, comprising total cholesterol, triglycerides, HDL-C, LDL-C, and VLDL-C, reflects the metabolic status of malnourished children and may improve following nutritional rehabilitation.[3] Hepatic steatosis, traditionally associated with

edematous malnutrition, has also been reported in non-edematous SAM.[4] Liver ultrasonography is a safe, non-invasive and reliable modality for detecting and monitoring hepatic steatosis.

This study aimed to evaluate serum lipid profile and liver ultrasonographic findings in children aged 6 months to <5 years with SAM, compare them with healthy controls and assess changes following 2 months of nutritional rehabilitation.

Aim: To evaluate serum lipid profile and liver ultrasonographic findings in children with severe acute malnutrition (SAM) and their changes following nutritional rehabilitation under aged 6 months to less than 5 years.

Objectives

- To assess serum lipid profile in children with SAM.
- To evaluate hepatic steatosis using liver ultrasonography.
- To determine the association between lipid profile abnormalities and hepatic steatosis.
- To compare findings between children with SAM and healthy controls.
- To assess changes after 2 months of nutritional rehabilitation.

MATERIALS AND METHODS

This hospital-based prospective observational study was conducted over one year at the Malnutrition Treatment Centre, Department of Pediatrics, Jawaharlal Nehru Medical College and Associated Group of Hospitals, Ajmer, Rajasthan. The study enrolled 100 children aged 6 months to <5 years with severe acute malnutrition (SAM) and 100 age-matched healthy controls.

Children were diagnosed with SAM according to WHO criteria: weight-for-length/height <−3 SD, mid-upper arm circumference (MUAC) <11.5 cm, visible severe wasting, or bilateral nutritional edema and healthy children of the same age group served as controls, were included in the study. Children with chronic liver disease, nephrotic syndrome, diabetes mellitus, viral hepatitis, acute illnesses affecting lipid metabolism, inborn errors of metabolism, family history of dyslipidemia, or other chronic disorders influencing lipid profile were excluded.

After obtaining written informed consent from parents/guardians, demographic, clinical, nutritional and anthropometric data were recorded using a predesigned proforma. Anthropometric assessment included weight, length/height, MUAC and body mass index (BMI) measured using standardized techniques.

Fasting venous blood samples were collected to estimate serum lipid profile, including total cholesterol, triglycerides, HDL-C, LDL-C, and VLDL-C, at admission and after 2 months of nutritional rehabilitation in children with SAM.

Liver ultrasonography was performed to evaluate hepatic steatosis by assessing liver echogenicity relative to the renal cortex, portal vein wall visibility and posterior beam attenuation. Hepatic steatosis was graded as Grade 0 (normal), Grade I (mild), Grade II (moderate) and Grade III (severe). Ultrasonography was repeated after 2 months of nutritional rehabilitation to assess treatment response.

Statistical analysis was performed using SPSS version 20 (Version 26). Continuous variables were expressed as mean ± standard deviation and categorical variables as frequencies and percentages. Student's t-test, Chi-square test and paired analysis were used for group comparisons. A p value <0.05 was considered statistically significant.

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RESULTS

A total of 100 children with severe acute malnutrition (SAM) and 100 age-matched healthy controls were included. The mean age of children with SAM was 12.93 ± 5.33 months, with most participants aged 6–24 months. Males constituted 54% of both the SAM and control groups. Among children with SAM, 95% fulfilled the WHO weight-for-height criterion, 62% had MUAC <11.5 cm, and 23% presented with bilateral nutritional edema [Table 1].

Table 1: Baseline characteristics of children with severe acute malnutrition

Characteristic	SAM (n=100)
Mean age (months)	12.93 ± 5.33
Male, n (%)	54 (54)
Female, n (%)	46 (46)
Weight (kg)	5.51 ± 0.82
Height (cm)	70.26 ± 8.17
MUAC (cm)	10.99 ± 1.18
BMI (kg/m²)	11.02 ± 1.65
Weight-for-height <−3 SD	95 (95%)
MUAC <11.5 cm	62 (62%)
Bilateral edema	23 (23%)

Serum lipid parameters were significantly lower in children with SAM at admission compared with controls. Following 2 months of nutritional rehabilitation, significant improvements were observed in total cholesterol, triglycerides, and HDL-C ($p<0.05$), while increases in LDL-C and VLDL-C were not statistically significant [Table 2]. The proportion of children with lipid values below the 5th percentile decreased markedly after rehabilitation,

with normalization of lipid levels in the majority of participants.

Table 2: Changes in serum lipid profile after nutritional rehabilitation

Parameter	Admission (Mean ± SD)	2 Months (Mean ± SD)	p value
Total cholesterol (mg/dL)	102.16 ± 29.68	168.16 ± 28.18	<0.001
Triglycerides (mg/dL)	79.72 ± 37.17	99.83 ± 32.08	0.020
HDL-C (mg/dL)	38.78 ± 13.82	50.41 ± 9.62	<0.001
LDL-C (mg/dL)	54.63 ± 21.50	62.20 ± 22.60	0.064
VLDL-C (mg/dL)	21.42 ± 8.25	23.60 ± 8.90	0.072

Liver ultrasonography demonstrated hepatic steatosis in 94% of children with SAM, whereas all controls had normal liver findings. Grade II steatosis was the predominant abnormality at baseline. Hepatic steatosis was observed in both edematous and non-edematous SAM, although advanced grades were more frequent among edematous children [Table 3].

Table 3: Liver ultrasonographic findings at baseline

Liver ultrasonography	Controls n (%)	SAM n (%)
Grade 0	100 (100)	6 (6)
Grade I	0	35 (35)
Grade II	0	57 (57)
Grade III	0	2 (2)

After nutritional rehabilitation, Grade II and Grade III steatosis resolved completely, with most children demonstrating either normal liver echogenicity or only mild (Grade I) steatosis [Table 4].

Table 4: Distribution of hepatic steatosis in edematous and non-edematous SAM

SAM subtype	Grade 0	Grade I	Grade II	Grade III
Non-edematous (n=77)	6	32	38	1
Edematous (n=23)	0	3	19	1
Total (n=100)	6	35	57	2

Although hepatic steatosis was observed in both edematous and non-edematous SAM, Grade II/III steatosis was significantly more frequent in children with edema ($p<0.001$).

Follow-up liver ultrasonography after 2 months- After 2 months of nutritional rehabilitation, hepatic steatosis decreased markedly. No Grade II or Grade III hepatic steatosis was observed after treatment. Most children shifted to Grade 0 or Grade I hepatic steatosis.

Table 5: Liver ultrasonography after 2 months of nutritional rehabilitation

Parameters	Grade 0	Grade I
cholesterol	64	36
triglyceride	47	53
LDL-C	68	32
HDL-C	67	33
VLDL-C	66	34

This shows that hepatic steatosis improved after nutritional rehabilitation.

DISCUSSION

The present study evaluated serum lipid profile and liver ultrasonographic findings in children with severe acute malnutrition (SAM) and assessed their response to nutritional rehabilitation. The principal findings were that children with SAM had significantly reduced serum lipid concentrations and a high prevalence of hepatic steatosis compared with healthy controls. Nutritional rehabilitation resulted in significant improvement in lipid abnormalities and marked resolution of hepatic steatosis.[5]

Most children with SAM were younger than 2 years, consistent with the period of rapid growth, increased nutritional demands, inappropriate complementary feeding, and frequent infections, making this age group particularly vulnerable to severe malnutrition.[6]

Children with SAM exhibited significantly lower serum total cholesterol, triglycerides, HDL-C, LDL-C, and VLDL-C at admission than healthy controls, indicating profound alterations in lipid metabolism. Following 2 months of nutritional rehabilitation, total cholesterol, triglycerides, and HDL-C improved significantly, whereas LDL-C and VLDL-C showed non-significant improvement. These findings suggest that correction of nutritional deficiency restores hepatic lipid metabolism and lipoprotein synthesis.[7]

Our findings are consistent with those of Rahmatalla et al., who reported significantly reduced serum total cholesterol, triglycerides, HDL-C, and LDL-C in malnourished children compared with healthy controls. Similarly, Viswanathan et al. demonstrated

improvement in lipid abnormalities following medical nutrition therapy in children with severe wasting, while Verma et al. also observed significant dyslipidemia among malnourished children. The overall agreement between these studies and the present findings supports the role of malnutrition in disrupting lipid metabolism.[8]

Liver ultrasonography revealed hepatic steatosis in 94% of children with SAM, whereas all healthy controls had normal liver findings. Grade II steatosis was the predominant abnormality at presentation and steatosis was observed in both edematous and non-edematous SAM, although higher grades were more frequent in edematous children. These observations suggest that hepatic fat accumulation is not confined to edematous malnutrition and may represent a broader manifestation of severe nutritional deficiency.[9]

These findings are comparable with those reported by Doherty et al. and Lalwani et al., who demonstrated hepatic steatosis in children with severe malnutrition and showed that fatty liver may occur in both edematous and non-edematous forms. Similar to our study, they also reported substantial improvement following nutritional rehabilitation, supporting the reversible nature of hepatic steatosis in SAM.

An important strength of the present study is the combined evaluation of serum lipid profile and liver ultrasonography before and after nutritional rehabilitation. This comprehensive assessment demonstrated parallel improvement in biochemical and radiological abnormalities, highlighting the usefulness of these parameters for monitoring metabolic recovery in children with SAM.

Overall, the present study demonstrates that severe acute malnutrition is associated with significant dyslipidemia and a high prevalence of hepatic steatosis, both of which improve substantially following nutritional rehabilitation. These findings support the use of serum lipid profile and liver ultrasonography as valuable adjuncts in the assessment and follow-up of children with SAM.

CONCLUSION

Children with severe acute malnutrition (SAM) exhibited significant dyslipidemia, characterized by reduced serum total cholesterol, triglycerides, HDL-C, LDL-C, and VLDL-C, along with a high prevalence of hepatic steatosis at admission. Nutritional rehabilitation resulted in significant improvement in total cholesterol, triglycerides, and HDL-C, while LDL-C and VLDL-C showed a trend toward recovery.

Hepatic steatosis was highly prevalent in both edematous and non-edematous SAM, indicating that fatty liver is not restricted to the edematous form of malnutrition. Marked resolution of hepatic steatosis following nutritional rehabilitation highlights the reversible nature of these hepatic changes with appropriate nutritional management.

The findings of this study demonstrate that serum lipid profile and liver ultrasonography are valuable adjunctive tools for the assessment and monitoring of metabolic recovery in children with SAM. Their combined use may facilitate early identification of metabolic abnormalities, objective evaluation of treatment response, and improved clinical follow-up during nutritional rehabilitation.

Recommendations

- Lipid profile should be considered in children admitted with severe acute malnutrition.
- Liver ultrasonography may be useful for detecting hepatic steatosis in SAM.
- Children with both edematous and non-edematous SAM should be evaluated for hepatic steatosis.
- Nutritional rehabilitation should be started early and follow-up should be done.
- Larger multicentric studies with longer follow-up are needed to further assess lipid profile and hepatic steatosis in SAM.

Limitations

- This was a single-centre hospital-based study.
- Liver biopsy was not done, as ultrasonography was used for assessment of hepatic steatosis.
- Long-term follow-up beyond 2 months was not done.
- Detailed dietary intake and micronutrient assessment were not included.
- Ultrasonography may have observer variation.

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