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Original Article

Paediatrics Section

Effect of Antiepileptic Drugs on Serum Lipid Profile among Children with Epilepsy at a Tertiary Care Hospital, Chennai, India

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ABSTRACT

Introduction: An arsenal of Antiepileptic Drugs (AED) is used in the management of childhood seizure disorders. Most of them are taken long-term. These drugs have the potential to cause hyperlipidaemia by inducing the P450 enzyme system. The alteration in lipid profile caused by long-term use of antiepileptic drugs in children needs to be studied to reduce the risk of future atherosclerosis.

Aim: To analyse the effect of antiepileptic drugs on serum lipid profile in children with epilepsy in a tertiary care hospital.

Materials and Methods: This prospective descriptive study was conducted in the Outpatient and Inpatient Wards of the Department of Paediatrics and Neurology, Institute of Child Health and Hospital for Children, Chennai, Tamil Nadu, India, from February 2017 to September 2017. The study involved a total of 155 children, who were on monotherapy antiepileptic drugs for atleast 6 months (33 on phenytoin, 42 on phenobarbitone, 20 on levetiracetam, 20 on carbamazepine, 40 on sodium valproate). A corresponding number of children, who attended the General Outpatient Department for acute Upper Respiratory Tract Infection (URTI) and were otherwise healthy, were included as controls. A blood sample (3 mL) was drawn after an overnight fast for serum glucose, liver enzymes, Total Cholesterol (TC), High Density Lipoprotein-Cholesterol (HDL-C), Low Density Lipoprotein-Cholesterol (LDL-C), Very Low Density Lipoprotein-Cholesterol (VLDL-C) and Triglycerides (TG) measurement. Chi-square test was performed to find out the significance of association and independent t-test was used to compare the mean between various groups.

Results: Cytochrome P450 (CYP) enzyme inducers like carbamazepine, phenytoin and phenobarbitone significantly modified serum lipids in epileptic children when compared to healthy controls. In children on long-term phenytoin monotherapy, mean cholesterol levels were significantly higher in the cases compared to controls (156.73±31.93 mg/dL vs 105.03±8.60 mg/dL, p<0.0001), significantly elevated TG (123.48±25.99 mg/dL vs 87.88±12.16 mg/dL, p<0.0001), and HDL-C level was significantly lower (44.52±10.14 mg/dL vs 56.73±12.56 mg/dL, p<0.0001) than in controls. Phenobarbitone use was associated with significantly higher levels of cholesterol (164.97±34.41 mg/dL vs 107.76±9.28 mg/dL, p<0.0001), LDL (155.27±28.55 mg/dL vs 93.36±6.81 mg/dL, p<0.0001), and TG (125.55±42.19 mg/dL vs 86.30±8.12 mg/dL, p<0.001) and lower HDL (46.30±9.47 mg/dL vs 57.73±14.41 mg/dL, p<0.0001). Levetiracetam was not associated in significant alteration in both liver enzymes and lipid profile (p>0.05). Carbamazepine monotherapy was associated with higher levels of cholesterol (180.50±28.06 mg/dL vs 112.15±13.55 mg/dL, p<0.0001), LDL (138.85±22.55 mg/dL vs 82.45±12.12 mg/dL, p<0.0001) and TG (142.80±9.48 mg/dL vs 85.40±6.29 mg/dL, p<0.0001) when compared to healthy controls. There was no alteration in lipid profile in valproate monotherapy. Valproate monotherapy was associated with significant increase in levels of Serum Glutamic Oxaloacetic Transaminase (SGOT) and Serum Glutamic Pyruvic Transaminase (SGPT) when compared to mean levels 40.35±11.208 IU/L, and 40.70±8.809 IU/L, respectively) observed in other AEDs and significant increase in SGPT levels when compared to healthy controls 36.50±10.61 IU/L in cases vs 40.70±8.81 IU/L in controls).

Conclusion: Levetiracetam did not produce significant changes in the serum lipid profile and liver enzymes and appears to be safe to use in children for long-term epilepsy management, especially in children with baseline deranged lipid profile.

Keywords: Levetiracetam, Monotherapy, Phenobarbitone, Phenytoin, Valproate

INTRODUCTION

Hyperlipidaemia in young children is an important risk factor for the development of coronary heart disease in later life. It is well-known that besides high Total Cholesterol (TC) and Triglyceride (TG) concentrations, increased Low Density Lipoprotein-Cholesterol (LDL-C) and decreased High Density Lipoprotein-Cholesterol (HDL-C) also contribute to cardiovascular diseases [1]. Long-term antiepileptic therapy has been known to affect the frequency and development of cardiovascular diseases [2,3]. Many studies have investigated the effect of Antiepileptic Drugs (AED) on serum lipid levels in adults but very few studies have evaluated the impact of AEDs on the lipid profile in children with epilepsy [3,4].

Alteration in serum lipid levels by AEDs have been shown to significantly increase the ischaemic vascular events in adults and changing from P450 enzyme inducing AEDs to non enzyme inducing ones have been noted to significantly decrease the hyperlipidaemia and subsequent risk of atherogenesis [5,6]. Multiple risk factors like seizures plus coronary artery disease, could increase the chance of sudden death in patients with epilepsy. Even a subtle myocardial lesion associated with end-vessel coronary artery disease might expose the patients with epilepsy to sudden unexpected death. Therefore, even small changes in the serum lipid profile could have serious consequences in patients with epilepsy [7].

Previous studies have shown significant relationship between serum lipid levels and AEDs, especially with the enzyme inducers like phenytoin, phenobarbitone, and carbamazepine [3,8].

However, such studies are lacking in South Indian population. Single nucleotide polymorphisms (SNPs) in the *CYP2C8* gene influence the adverse reactions and/or the efficacy of drugs metabolised by this enzyme. Inherent genetic differences between the South and North Indian populations may affect the metabolism of AEDs metabolised by this enzyme. If a link between blood lipid

levels and AEDs use can be established, these treatments can be used with caution in those who have pre-existing risk factors for metabolic syndrome, such as a family history of atherosclerosis, obesity, dyslipidaemia, hypertension, or insulin resistance. Periodic screening and counselling for lifestyle modifications (low animal dietary fat intake with no calorie restriction) may also be warranted in those situations.

Similarly, liver enzymes like Serum Glutamic Oxaloacetic Transaminase (SGOT) and Serum Glutamic Pyruvic Transaminase (SGPT) can serve as markers of hepatocellular injury. Though relatively rare, when compared with other consistently known hepatotoxic drugs, the hepatotoxicity induced by AEDs can lead to death or an acute liver failure which could imperatively require liver transplantation [9].

Therefore, the goal of this study was to evaluate the effects of AEDs used commonly in children like carbamazepine, phenobarbitone, phenytoin, valproic acid, and levetiracetam on lipid profiles and liver enzymes in epileptic children treated at the tertiary care hospital.

MATERIALS AND METHODS

This prospective descriptive study was conducted in the Outpatient and Inpatient Wards of the Department of Paediatrics and Neurology, Institute of Child Health and Hospital for Children, Chennai, Tamil Nadu, India, from February 2017 to September 2017. The Institutional Ethics Committee was obtained (vide letter number-ECR/270/Inst./TN/2013).

Inclusion criteria: Cases group: Children receiving anticonvulsant monotherapy for atleast six months were included as cases.

Control group: Corresponding numbers of children who attended the General Outpatient Department for acute Upper Respiratory Tract Infection (URTI) and siblings of cases who were otherwise healthy and consented for the study were taken as controls.

Exclusion criteria: Children with chronic liver, heart or renal disease, thyroid disorder or other endocrinopathies, progressive neurological or psychiatric illness, on drugs which may alter the lipid profile or liver enzymes such as steroids, insulin, and statins were excluded from the study.

Considering the duration of study and number of children on monotherapy for the various AEDs, a convenient sampling was followed. A total of 155 patients on monotherapy AEDs for at least 6 months.

- 33 in the phenytoin group
- 42 in the phenobarbitone group
- 20 in the levetiracetam group
- 20 in the carbamazepine group
- 40 in the sodium valproate group

Corresponding numbers for control group were also considered. After obtaining the written informed consent from the parent/guardian of the children, a clinical evaluation was performed as per a predesigned proforma.

Study Procedure

A blood sample (3 mL) was drawn after an overnight fast for serum glucose, liver enzymes, TC, HDL-C, LDL-C, Very Low Density Lipoprotein-Cholesterol (VLDL-C), and TG measurement. Total cholesterol was assessed by cholesterol oxidase peroxidase enzyme method, HDL-C by direct enzymatic analysis method and serum TG by glycerol peroxidase method. All these parameters were assessed by the Roche Cobas C311 analyser. VLDL-C and LDL-C were derived using Friedewald formula.

STATISTICAL ANALYSIS

All analyses were performed using the Statistical Package for the Social Sciences (SPSS) version 20.0. Chi-square test was performed to find out the significance of association and Independent t-test was used to compare the mean between various groups. A p-value <0.05 was considered statistically significant.

RESULTS

It was observed that most children using phenobarbitone monotherapy were below 2 years of age, phenytoin between 2-4 years and sodium valproate between 4-6 years of age. Both male and female children were equally distributed in the various groups of AEDs compared in the study. Age and sex distribution of children in the various groups are given in [Table/Fig-1] and were comparable with their controls.

On comparing the SGOT and SGPT levels in various AED groups, it has been found that there was significant elevation of both in children taking sodium valproate, although all of them were asymptomatic (mean 40.35±11.208 IU/L for SGOT, and 40.70±8.809 IU/L for SGPT) [Table/Fig-2,3].

When TC levels were compared, children taking carbamazepine group (180.50±28.059 mg/dL) was found to have elevated levels (p<0.0001) followed by phenobarbitone (p=0.0026) and then phenytoin (p=0.0511) [Table/Fig-4].

Antiepileptic drug	Mean age (years)		p-value	Gender				p-value
				Cases		Control		
	Cases	Control		Male	Female	Male	Female	
Phenytoin	5.6	6.3	0.3212	20	13	18	15	0.618
Phenobarbitone	1.5	1.8	0.2168	23	10	20	13	0.438
Levetiracetam	3.4	5.5	0.844	11	9	11	9	1
Carbamazepine	5.6	7.2	0.3661	9	11	9	11	1
Sodium valproate	7.1	6.6	0.7138	22	18	22	18	1

[Table/Fig-1]: Age and sex distribution among cases and controls in the various AED groups.

Antiepileptic drugs	Mean SGOT (Mean±SD) (IU/L)	p-value
Phenytoin	28.33±5.066	0.0005
Phenobarbitone	32.73±6.311	0.3141
Levetiracetam	38.15±12.987	0.2650
Carbamazepine	37.15±12.987	0.4570
Sodium valproate	40.35±11.208	**0.0117**
Mean SGOT level in all children on AEDs	35.17±10.659	

[Table/Fig-2]: Mean SGOT levels in all children on AEDs compared against that in the specific AED group.

Antiepileptic drugs	Mean SGPT (Mean±SD) (IU/L)	p-value
Phenytoin	27.88±5.872	**0.0001**
Phenobarbitone	29.97±5.632	**0.0027**
Levetiracetam	38.05±9.506	0.1696
Carbamazepine	38.05±9.506	0.1696
Sodium valproate	40.70±8.809	**0.0021**
Mean SGPT level in all children on AED	34.65±9.374	

[Table/Fig-3]: Mean SGPT levels in all children on AEDs compared against that in the specific AED group.

Antiepileptic drugs	Cholesterol (mg/dL) (Mean±SD)	p-value
Phenytoin	156.73±31.930	**0.0511**
Phenobarbitone	164.97±34.414	**0.0026**
Levetiracetam	118.85±10.674	**0.0004**
Carbamazepine	180.50±28.059	**<0.0001**
Sodium valproate	105.63±8.161	**<0.0001**
Mean cholesterol levels in all children on AEDs	142.66±37.878	

[Table/Fig-4]: Mean cholesterol levels in all children on AEDs compared against that in the specific AED group.

On comparing the levels of LDL-C in the above groups, mean levels were higher in children taking phenobarbitone (mean 155.27±28.547 mg/dL), followed by carbamazepine [Table/Fig-5].

Antiepileptic drugs	LDL-C (mg/dL) (Mean±SD)	p-value
Phenytoin	92.06±24.334	**0.0021**
Phenobarbitone	155.27±28.547	**<0.0001**
Levetiracetam	84.90±11.670	**0.0005**
Carbamazepine	138.85±22.549	**0.0010**
Sodium valproate	94.60±6.831	**0.0026**
Mean LDL-C in all children in AEDs	112.47±34.760	

[Table/Fig-5]: Mean LDL-C levels in all children on AEDs compared against that in the specific AED group.

Mean TG levels were elevated in children taking carbamazepine (mean 142.80±9.479 mg/dL), followed by those children on phenobarbitone and phenytoin. Lowest mean levels were found in children on sodium valproate and the least levels were found with those children on levetiracetam [Table/Fig-6]. There was no significant alteration in the mean HDL-C levels in the various AEDs [Table/Fig-7]. In the children taking levetiracetam and carbamazepine drug, the VLDL-C levels were elevated (mean 27.65±1.478 and 28.30±8.240 mg/dL respectively) when compared with the other children [Table/Fig-8]. In children on long-term phenytoin monotherapy, mean cholesterol levels were significantly higher in the cases compared to controls (p<0.0001) and HDL-C level was in the lower range (p<0.0001) there were no significant alterations noted in the other lipid levels and liver enzymes [Table/Fig-9]. As expected, phenobarbitone was most commonly used in less than 2 years old children. Whereas, the TC, TG and LDL-C were all increased in the children who were taking phenobarbitone (mean values of 164.97 mg/dL, 125.55 mg/dL and 155.27 mg/dL

Antiepileptic drugs	Triglyceride (mg/dL) (Mean±SD)	p-value
Phenytoin	123.48±25.986	0.0673
Phenobarbitone	125.55±42.194	**0.0342**
Levetiracetam	83.65±6.201	**0.0001**
Carbamazepine	142.80±9.479	**<0.0001**
Sodium valproate	89.88±7.875	**<0.0001**
Mean TG level in all children on AEDs	111.93±31.999	

[Table/Fig-6]: Mean TG levels in all children on AEDs compared against that in the specific AED group.

Antiepileptic drugs	HDL-C (mg/dL) (Mean±SD)	p-value
Phenytoin	44.52±10.143	0.5375
Phenobarbitone	46.30±9.465	1
Levetiracetam	49.30±5.273	0.1047
Carbamazepine	47.25±6.060	0.5913
Sodium valproate	45.78±5.122	1
Mean HDL-C in all children on AEDs	46.29±7.756	

[Table/Fig-7]: Mean HDL-C levels in all children on AEDs compared against that in the specific AED group.

respectively) when compared with the control group, HDL-C was decreased in lipid profile and liver enzyme levels in patients receiving phenobarbitone [Table/Fig-10].

Antiepileptic drugs	VLDL-C (mg/dL) (Mean±SD)	p-value
Phenytoin	18.18±8.998	**0.0223**
Phenobarbitone	19.64±8.703	0.2414
Levetiracetam	27.65±6.612	**0.0048**
Carbamazepine	28.30±8.240	**0.0052**
Sodium valproate	20.85±7.156	0.5162
Mean VLDL-C in all children on AEDs	21.92±8.821	

[Table/Fig-8]: Mean VLDL-C levels in all children on AEDs compared against that in the specific AED group.

Parameters	Phenytoin group		p-value
	Control (Mean±SD)	Cases (Mean±SD)	
Serum glucose (mg/dL)	101.73±22.26	99.97±24.46	0.761
SGOT (IU/L)	29.12±7.35	28.33±5.07	0.614
SGPT (IU/L)	29.58±5.15	27.88±5.87	0.216
TC (mg/dL)	105.03±8.60	156.73±31.93	**<0.0001**
LDL-C (mg/dL)	93.36±6.81	92.06±24.33	0.768
TG (mg/dL)	87.88±12.16	123.48±25.99	**<0.0001**
HDL-C (mg/dL)	56.73±12.56	44.52±10.14	**<0.0001**
VLDL-C	20.82±7.38	18.18±9.00	0.198

[Table/Fig-9]: Lipid profile and liver enzyme levels in patients receiving phenytoin.

Parameters	Phenobarbitone group		p-value
	Control (Mean±SD)	Cases (Mean±SD)	
Serum glucose (mg/dL)	102.61±19.01	99.97±24.46	0.627
SGOT (IU/L)	30.88±7.81	32.73±6.31	0.294
SGPT (IU/L)	31.21±7.63	29.97±5.63	0.454
TC (mg/dL)	107.76±9.28	164.97±34.41	**<0.0001**
LDL-C (mg/dL)	93.36±6.81	155.27±28.55	**<0.0001**
TG (mg/dL)	86.30±8.12	125.55±42.19	**<0.0001**
HDL-C (mg/dL)	57.73±14.41	46.30±9.47	**<0.0001**
VLDL-C (mg/dL)	20.82±7.38	19.64±8.70	0.554

[Table/Fig-10]: Lipid profile and liver enzyme levels after receiving phenobarbitone.

There were no children on levetiracetam monotherapy less than 2 years old in the study population. Levetiracetam appeared to be a relatively safe drug with no alteration in either lipid profile or liver enzymes noted when compared to controls [Table/Fig-11].

Parameters	Levetiracetam group		p-value
	Control (Mean±SD)	Cases (Mean±SD)	
Serum glucose (mg/dL)	99.40±20.99	109.00±25.15	0.198
SGOT (IU/L)	32.40±8.41	38.15±12.99	0.105
SGPT (IU/L)	32.55±9.83	38.05±9.51	0.080
TC	112.15±13.55	118.85±10.67	0.091
LDL-C (mg/dL)	82.45±12.12	84.90±11.67	0.519
TG (mg/dL)	85.40±6.29	83.65±6.20	0.381
HDL-C (mg/dL)	53.30±9.68	49.30±5.27	0.113
VLDL-C (mg/dL)	28.45±4.45	27.65±6.61	0.656

[Table/Fig-11]: Lipid profile and liver enzyme levels in patients receiving levetiracetam.

In the carbamazepine group, the TC, LDL-C, TG levels were significantly elevated (p<0.0001) when compared with the controls [Table/Fig-12].

Parameters	Carbamazepine group		p-value
	Control (Mean±SD)	Cases (Mean±SD)	
Serum glucose (mg/dL)	106.55±19.41	109.00±25.15	0.732
SGOT (IU/L)	30.45±7.64	37.15±12.99	0.054
SGPT (IU/L)	32.75±10.22	38.05±9.51	0.098
TC (mg/dL)	112.15±13.55	180.50±28.06	**<0.0001**
LDL-C (mg/dL)	82.45±12.12	138.85±22.55	**<0.0001**
TG (mg/dL)	85.40±6.29	142.80±9.48	**<0.0001**
HDL-C (mg/dL)	49.65±6.34	47.25±6.06	0.228
VLDL-C (mg/dL)	29.90±5.96	28.30±8.24	0.486

[Table/Fig-12]: Lipid profile and liver enzyme levels in patients receiving carbamazepine.

In children on monotherapy with sodium valproate, no significant differences were noted in lipid profiles when compared to controls but showed significant elevation of SGPT {40.70 IU/L (p=0.058)} [Table/Fig-13].

Parameters	Group		p-value
	Control (Mean±SD)	Cases (Mean±SD)	
Serum glucose (mg/dL)	110.93±28.00	113.35±19.88	0.656
SGOT (IU/L)	40.63±13.10	40.35±11.21	0.920
SGPT (IU/L)	36.50±10.61	40.70±8.81	0.058
TC (mg/dL)	105.05±9.03	105.63±8.16	0.766
LDL-C (mg/dL)	93.55±7.75	94.60±6.83	0.522
TG (mg/dL)	87.80±4.37	89.88±7.87	0.149
HDL-C (mg/dL)	46.10±4.56	45.78±5.12	0.765
VLDL-C (mg/dL)	18.26±5.97	20.85±7.16	0.083

[Table/Fig-13]: Lipid profile and liver enzyme levels in patients receiving sodium valproate.

DISCUSSION

Patients with epilepsy have to undergo chronic treatment with AEDs. It is not only important that their seizures be under control but also that adverse effects due to long-term AEDs should be minimal. Hence, periodic screening of these children for any risk factors is essential.

Statistically significant high mean TC and TG levels were observed in the group receiving phenytoin for more than six months when compared with the control group with the mean value of 156.73 and 123.48 mg/dL, respectively. This observation was similar to the study conducted by Manimekalai K et al., who observed statistically significant high mean TC, HDL-C, LDL-C, and TG levels in young adults receiving phenytoin when compared with the control group [10]. Sharma R et al., also observed significantly higher level of TC in children taking phenytoin [11].

Kantoush MM et al., also reported significant increase of serum levels of TC, LDL-C, and HDL-C [12]. This was contrary to the study conducted by Calandre EP et al., who studied the effect of chronic phenytoin treatment on serum lipid profile in epileptic patients and found that patients showed higher HDL-C, apolipoproteins A and A1, Gamma-Glutamyl Transpeptidase (GGT) levels and lower LDL-C and apolipoprotein B values [13]. These contradictory results were similar to the study conducted by Dhir A et al., who concluded that the children who took valproate had significantly higher mean serum TG and TC when compared to children on phenytoin monotherapy [14].

In the group who received phenobarbitone, TC, TG, and LDL-C were all increased in the children with the mean values of 164.97 mg/dL, 125.55 mg/dL and 155.27 mg/dL when compared with the control group. HDL-C was decreased in the cases when compared with that of the control group. VLDL-C did not alter in the phenobarbitone group.

Kantoush MM et al., and Eiris JM et al., have observed that children receiving carbamazepine or phenobarbitone, had higher mean TC and LDL-C levels than controls. Along with other lipid parameters, HDL-C was also reported to be elevated in both the studies [12,15]. Yilmaz E et al., concluded in their study that the serum TG levels increased after 3 months of treatment with phenobarbitone and remained high after 1 year but no difference was found for TC, HDL-C and LDL-C values. There was no statistical significance in the values of serum glucose, SGOT, and SGPT in those children [16].

In the present study, no statistically significant elevation of lipids was found in the children who were on levetiracetam. Only very few studies are available with levetiracetam, as the drug is relatively new. Manimekalai K et al., did not observe any statistically significant difference among mean TC, HDL-C, LDL-C, and TG levels in the group receiving levetiracetam [10]. There is no literature available regarding effect levetiracetam on lipid function. However, no significant effects on lipid metabolism by both levetiracetam and sodium valproate was observed in the present study. This may be because both these AEDs are non-inducers of CYP51 enzyme.

In the carbamazepine group, there was significant elevation in TC, LDL-C, and TG with the mean values of 180.50 mg/dL, 138.85 mg/dL, and 142.80 mg/dL, respectively. HDL-C and VLDL-C did not show any statistical difference when compared with the controls. In the study conducted by Kantoush MM et al., carbamazepine caused significant increase of serum TC, LDL-C, and TG compared to controls. But along with it, HDL-C and VLDL-C were also raised in their study [12]. Kumar P et al., also observed that adults receiving carbamazepine had significant increase in serum levels of TG and VLDL-C, but no significant changes in serum levels of TC and HDL-C [17].

There was no statistical difference in the sodium valproate group when serum glucose SGOT, SGPT, TC, LDL-C, HDL-C, TG, and VLDL-C were compared with that of the control group. This is similar to the conclusion derived by Dewan P et al., and Mugloo MM et al., [18,19].

This is also supported by another study by Yaser AA et al., who studied serum lipids and thyroid hormone level changes in epileptic children on valproate monotherapy, where they concluded that valproate has no effect on either lipids or thyroid functions in epileptic children treated with that drug [20]. Dhir A et al., have however observed that children on valproate had significantly higher mean serum TG and TC when compared to children on phenytoin monotherapy [14].

Anticonvulsant drugs, especially the enzyme inducers like carbamazepine, phenytoin, and phenobarbitone significantly modify serum lipids in epileptic children. Carbamazepine causes increase in the levels of TC, LDL-C, and TG. Phenobarbitone increases TC, LDL-C, TG and also lowers HDL-C. Phenytoin increases TC, TG and lowers HDL-C.

Phenytoin and phenobarbitone lowers HDL-C significantly. Hence, children on long-term therapy are at greater risk of atherogenesis. Baseline and serial lipid profile monitoring should be done in all children who are put on carbamazepine, phenytoin and phenobarbitone therapy.

Limitation(s)

The parameters could not be studied before initiation of the AEDs, and so, any confounding factors over time could not be eliminated.

CONCLUSION(S)

In conclusion, sodium valproate and levetiracetam do not appear to cause significant changes in the serum lipid profile. Sodium valproate caused a significant elevation of SGPT when compared with that of the controls. It should be avoided in children who have pre-existing liver disease, hepatic dysfunction and who are on other hepatotoxic drugs. Baseline Liver Function Tests (LFT) may be done in all children who are started on sodium valproate and serial

LFT monitoring may be done every 3-6 months. Levetiracetam did not produce significant changes in the serum lipid profile and liver enzymes; hence, it is safe to use in children for long-term management of seizures, especially in children with deranged lipid and hepatic enzyme profiles.

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