# Lipid and coagulation profiles in children with arterial ischemic stroke depending on the presence of focal cerebral arteriopathy

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## Abstract

Arteriopathy is one of the most important state predisposing to the development of arterial ischemic stroke (AIS) in children. Focal cerebral arteriopathy (FCA) refers to cases with arterial stenosis with no apparent cause. The aim of the present study was to assess levels of lipids and fibrinogen, activated partial thromboplastin time (APTT), protein C (PC) as well as antithrombin (AT) in AIS children with and without FCA. We retrospectively analysed 67 cases with AIS hospitalized in the Department of Paediatric Neurology at the Medical University of Silesia in Katowice (Poland) during 2002-2013. The age of the patients at the time of AIS was up to 18 years. The presence of FCA was confirmed by a radiologist. Data were analysed using STATISTICA 12.0 software. Stroke subtypes significantly differentiated study subgroups. Age, sex or heart disease were not

## Key words:

ischemic stroke, pediatric, arteriopathy, FCA, lipids, fibrinogen

related to FCA. Number of AIS symptoms did not differ between both subgroups however the presence of two or more neurological consequences of AIS were significantly more common in children with FCA (34% vs 4% in children without FCA, p=0.035). Post-stroke seizures and aphasia were observed only in AIS children with FCA. No relation in the mean levels of lipids, fibrinogen, APTT, PC and AT between the AIS children with and without FCA. Decreased level of PC was observed in 3 children without FCA (12.5%). Positive correlations between fibrinogen concentration and the levels of triglycerides (TG; r=0.256, p=0.039) as well as between fibrinogen and TG/HDL ratio (r=0.285, p=0.021) were found only in children with AIS and FCA, not in children with AIS but without FCA. In conclusion, FCA is associated with stroke subtypes and the presence of post-stroke consequences however lipid and coagulation profiles did not differentiate children with AIS and FCA from children with AIS but without FCA.

# Introduction

Arterial ischemic stroke (AIS) occurs in children with very low frequency. The pathology of childhood AIS and the impact of potential risk factors are still unclear. The most common states which predispose to AIS in children are: arteriopathies, thrombophilia, trauma, infections, heart diseases or some metabolic and mitochondrial diseases. Focal cerebral arteriopathy (FCA) is one of the subtypes of arteriopathy, which applies to cases with focal cerebral arterial stenosis with no apparent cause [1]. FCA is very common in children with AIS. Previously it was observed in 41% of children with AIS, among which 20% concerned unilateral focal cerebral arteriopathy [2]. FCA was also observed to be the main risk factor of recurrent pediatric AIS [3, 4, 5] as well as was related to post-stroke neurological consequences, especially seizures [1, 6]. Progressive arteriopathy was suggested to be an inflammatory state. The results of the study of Fullerton et al. [7] showed that in children with progressive arteriopathy some inflammatory biomarkers, i.e. high-sensitivity C-reactive protein and serum amyloid A are significant predictors of the recurrence of AIS.

Hypercoagulable state is very frequent at the acute phase of AIS. In the study of Goldenberg et al. [2], thrombophilia was present in 63% of patients with AIS and D-dimer was acutely elevated in 31% of them. The authors observed that arteriopathy and D-dimer were prognostic factors for poor outcome [2]. Dyslipidemia may be another important risk factor for AIS related with steno-occlusive arteriopathy [3]. In turn, abnormalities in lipid profiles in childhood may be related to a family history of dyslipidemia or premature cardiovascular disease.

The objective of the present study was to assess whether lipid and some coagulation related parameters (fibrinogen, APTT, PC and AT) differ between children with AIS and FCA and children with AIS but without FCA.

# Material and methods

## Patients

The present study was retrospective. We searched medical records for cases with AIS hospitalized in the Department of Paediatric Neurology at the Medical University of Silesia in Katowice (Poland) between 2002 and 2013.

The inclusion criteria into the study were: a) arterial ischemic stroke confirmed by a neuroimaging examination (computed tomography (CT) and/or magnetic resonance imaging (MRI)), b) age at onset – from the first month of life up to 18 years, c) available data on the serum lipids levels, plasma fibrinogen, APTT, PC and AT during the acute phase of AIS, and d) data on the cardiac examination carried out to determine the occurrence of heart disease. Children with embolic stroke were included to the

analysed group of patients. All patients were white, Polish Caucasians. Neuroimaging studies with the use of CT and/or MRI of all patients were assessed by a radiology specialist to confirm the presence of focal cerebral arteriopathy of childhood. It was defined as focal stenosis with abnormalities of the arterial wall not attributed to specific diagnoses such as moyamoya, arterial dissection, vasculitis, or post varicella angiopathy [1].

Patients were excluded when AIS occurred after the skull injury or when diagnosis other than AIS was made.

Ultimately, 67 paediatric patients were included to the study and divided into two subgroups: 1) children with AIS and the presence of FCA and 2) children with AIS but without FCA.

## Identification of AIS and its subtypes

Due to the retrospective nature of the study, we decided to identify arterial ischemic stroke according to the World Health Organization's International Classification of Diseases [8]. The following stroke subtypes were evaluated in analysed patients: partial anterior circulation infarct (PACI), posterior circulation infarct (POCI), lacunar anterior circulation infarct (LACI) and total anterior circulation infarct (TACI) [9, 10]. The above classification results from the location of vascular lesions as well as clinical and radiological symptoms, therefore it does not exclude its use in children.

## Neurological consequences of AIS

Four of the most common neurological consequences were analysed in the patients included to the present study: hemiparesis, seizures, aphasia and movement disorders other than hemiparesis.

## Serum lipid profile

All biochemical analyses were uniformly performed in Hospital Laboratory, during hospitalization of children suffering from AIS, in its acute phase.

We analysed the following lipid parameters: total cholesterol (TC), triglycerides (TG), and high-density lipoprotein cholesterol (HDL). The LDL concentrations were calculated from Friedewald's formula [11], using levels of TC, TG, and HDL. In addition, we calculated the level of non-HDL cholesterol by subtracting HDL cholesterol from TC [11], a very-low density lipoprotein (VLDL) level as a 20% of TG level [5] as well as the ratios of TC/HDL, TG/HDL and LDL/HDL. The high levels of all lipid parameters as well as the status of dyslipidaemia (either TC≥200 mg/dL, or HDL<40 mg/dL, or non-HDL≥145 mg/dL) and hypertriglyceridemia (for children aged up to 9 years TG≥100 mg/dL, and for children aged 10-19 years, TG≥130 mg/dL) were established according to the Sultan et al. [12]. Lipid ratio intervals were as follows: LDL/HDL normal <3, borderline 3–4, high >4; TC/HDL normal <4, borderline 4–5, high >5; TG/HDL normal <3, and above normal >3.

## Coagulation profile

We analysed the following coagulation related parameters: fibrinogen, APTT, PC and AT. We adopted the reference levels for the coagulation related parameters analysed in the present study according to the Hospital Laboratory, as follows: fibrinogen [2.2–4.2 g/l], APTT [26.0 – 40.0 s], PC [65.0–150.0%], AT [67.0–128.0%].

## Statistical analysis

Statistical analysis was performed with the use of STATISTICA 12.0 software (STATSOFT; Statistica, Tulsa, OK, USA). Mean values (M) and standard deviations (SD) were estimated for continuous variables, or absolute numbers (n) and relative numbers (%) of occurrence of items of categorical variables. The U Mann-Whitney test was used to compare continuous variables between the children with AIS and FCA and children with AIS but without FCA. Stochastic independence $\chi^2$ test with Yates's correction was used to compare categorical variables between patients with AIS in dependence to the presence of FCA. Pearson's correlation coefficients between lipid and coagulation related parameters were estimated. The value of $p \leq 0.05$ was considered to be statistically significant.

## Results

We analysed 67 children suffering from the first AIS, of whom 61% had FCA. Table 1 shows general and clinical characteristics of the total group as well as two analysed subgroups: 1) children with AIS and the presence of FCA and 2) children with AIS but without FCA.

The age of the included patients at AIS onset ranged from 1 month to 18 years old (7.8±5.5 on average in the total group). Approximately 2/3 of patients were male. In 19% of children heart diseases were diagnosed and positive family history of cardiovascular disease (CVD) concerned 16% of included cases. The age, sex, the presence of heart diseases and positive family history of CVD did not significantly differ between AIS children with and without FCA. However, we observed significant difference in the prevalence of particular stroke subtypes between both subgroups. The TACI as well as PACI stroke were the most common in AIS children with FCA while LACI subtype – in AIS children without FCA. In all analysed children two, three or four symptoms of AIS appeared the most frequently.

**Table 1.**
General and clinical characteristics of children with AIS depending on the presence of FCA

| Variable | Category | Total AIS group (N=67) | Children with AIS and FCA (N=41) | Children with AIS but without FCA (n=26) | p |
|---|---|---|---|---|---|
| Sex, n (%) | Girls | 24 (35.82) | 13 (31.71) | 11 (42.31) | 0.378 |
| | Boys | 43 (64.18) | 28 (68.29) | 15 (57.69) | |
| Age at AIS onset (years), M±SD | | 7.8±5.5 | 7.8±5.5 | 7.7±5.7 | 0.985 |
| Heart disease, n (%) | | 13 (19.40) | 8 (19.51) | 5 (19.23) | 0.977 |
| Positive family history of CVD, n (%) | | 11 (16.42) | 8 (19.51) | 3 (11.54) | 0.391 |
| Stroke subtypes, n (%) | LACI | 17 (25.37) | 5 (12.20) | 12 (46.15) | 0.007 |
| | TACI | 21 (31.34) | 17 (41.46) | 4 (15.38) | |
| | POCI | 8 (11.94) | 4 (9.76) | 4 (15.38) | |
| | PACI | 21 (31.34) | 15 (36.59) | 6 (23.08) | |
| Number of neurological symptoms of AIS, n (%) | 1 | 3 (4.48) | 1 (2.44) | 2 (7.69) | 0.523 |
| | 2 | 19 (28.36) | 11 (26.83) | 8 (30.77) | |
| | 3 | 17 (25.37) | 9 (21.95) | 8 (30.77) | |
| | 4 | 20 (29.85) | 13 (31.71) | 7 (26.92) | |
| | 5 | 6 (8.96) | 5 (12.20) | 1 (3.85) | |
| | 6 | 2 (2.99) | 2 (4.88) | 0 (0.00) | |
| Number of AIS consequences, n (%) | 0 | 18 (26.87) | 10 (24.39) | 8 (30.77) | 0.035 |
| | 1 | 34 (50.75) | 17 (41.46) | 17 (65.38) | |
| | 2 | 14 (20.90) | 13 (31.71) | 1 (3.85) | |
| | 3 | 0 (0.00) | 0 (0.00) | 0 (0.00) | |
| | 4 | 1 (1.49) | 1 (2.44) | 0 (0.00) | |
| Type of neurological consequence, n (%) | Hemiparesis | 45 (67.16) | 27 (65.85) | 18 (69.23) | 0.774 |
| | Seizures | 8 (11.94) | 8 (19.51) | 0 (0.00) | 0.016 |
| | Aphasia | 6 (8.96) | 6 (14.63) | 0 (0.00) | 0.041 |
| | Other movement disorders | 7 (10.45) | 6 (14.63) | 1 (3.85) | 0.151 |

AIS-arterial ischemic stroke, FCA-focal cerebral arteriopathy, LACI-lacunar anterior circulation infarct, PACI-partial anterior circulation infarct, POCI-posterior circulation infarct, TACI-total anterior circulation infarct, CVD-cerebrovascular diseases, M-mean value, SD-standard deviation

Number of neurological symptoms of AIS occurrence was not related to FCA. However, in case of neurological consequences of AIS we observed that presence of two or more post-stroke consequences are significantly more common in children with AIS and FCA (34% vs 4% in children with AIS but without FCA). Among those consequences, seizures and aphasia were observed only in AIS children with FCA.

## Lipid profile

Values of lipids concentrations, TC/HDL, TG/HDL and LDL/HDL ratios as well as prevalence of dyslipidaemia and hypertriglyceridemia did not significantly differ between AIS children with and without FCA (Table 2). The mean levels of lipids were as follows: TC – 169 mg/dL, LDL cholesterol – 92.5 mg/dL, HDL cholesterol – 53.3 mg/dL, non-HDL cholesterol – 115.5 mg/dL, TG – 111 mg/dL and VLDL – 22.2 mg/dL. Prevalence of dyslipidaemia was 51% and hypertriglyceridemia – 40%.

## Coagulation profile

Table 3 presents levels of the coagulation parameters. We did not observed significant differences in APTT or AT level between children with AIS and FCA and AIS children without FCA. However in 3 children with AIS and without FCA (12.5%) the level of PC was decreased while all children with AIS and FCA had the PC level within the normal range. Similarly, most of AIS patients with FCA (82.5%) had normal level of fibrinogen. Children with fibrinogen level above normal were found only in subgroup with AIS but without FCA (8%).

## Correlations between lipids and coagulation parameters

Correlation coefficients between lipids and coagulation related parameters in the total group are presented in Table 4. In children with AIS, fibrinogen concentration correlated positively with the levels of TG, VLDL as well as TG/HDL ratio. The higher fibrinogen level the greater are values of TG, VLDL and TG/HDL ratio on average. The correlations mentioned above were found only in children with AIS and FCA, not in AIS children without FCA. In total group no correlations between APTT, PC or AT and lipid levels or their ratios were found. However, there was a positive correlation between APTT and TC/HDL ratio in AIS children with FCA (r=0.396, p=0.017), while negative one – in AIS children without FCA (r=-0.483, p=0.019).

**Table 2.**
Lipid concentrations in children with AIS depending on the presence of FCA

| Lipid parameter | Total AIS group | Children with AIS and FCA | Children with AIS but without FCA | p |
|---|---|---|---|---|
| TC (mg/dL), M±SD | 168.79±33.51 | 168.59±31.89 | 169.12±36.57 | 0.882 |
| LDL (mg/dL), M±SD | 92.54±34.60 | 96.29±32.75 | 86.61±37.22 | 0.229 |
| HDL (mg/dL), M±SD | 53.30±26.45 | 49.05±20.92 | 60.00±32.72 | 0.088 |
| Non-HDL (mg/dL), M±SD | 115.50±43.59 | 113.45±43.79 | 118.72±43.95 | 0.520 |
| TG (mg/dL), M±SD | 111.00±34.73 | 112.15±37.95 | 109.19±29.57 | 0.616 |
| VLDL (mg/dL), M±SD | 22.20±6.95 | 22.43±7.59 | 21.84±5.91 | 0.616 |
| TC/HDL, M±SD | 3.69±1.46 | 3.83±1.30 | 3.47±1.70 | 0.250 |
| LDL/HDL, M±SD | 2.11±1.08 | 2.26±1.07 | 1.87±1.08 | 0.226 |
| TG/HDL, M±SD | 2.41±1.15 | 2.58±1.26 | 2.13±0.90 | 0.141 |
| Dyslipidaemia, n (%) | 34 (50.75) | 21 (51.22) | 13 (50.00) | 0.922 |
| Hypertriglyceridemia, n (%) | 27 (40.30) | 17 (41.46) | 10 (38.46) | 0.807 |

AIS-arterial ischemic stroke, FCA-focal cerebral arteriopathy, TC-total cholesterol, LDL-low density lipoprotein, HDL-high density lipoprotein, TG-triglycerides, VLDL-very low density lipoprotein, M-mean value, SD-standard deviation

**Table 3.**
Levels of coagulation related parameters in children with AIS depending on the presence of FCA

| Coagulation--related parameters | | Total AIS group | Children with AIS and FCA | Children with AIS but without FCA | p |
|---|---|---|---|---|---|
| APTT (s) | M±SD | 32.61±3.63 | 32.29±3.77 | 33.11±3.44 | 0.421 |
| | below normal | 3 (5.08) | 1 (2.78) | 2 (8.70) | 0.313 |
| | normal | 56 (94.92) | 35 (97.22) | 21 (91.30) | |
| Fibrinogen (g/L) | M±SD | 2.73±0.76 | 2.82±0.89 | 2.58±0.49 | 0.450 |
| | below normal | 14 (21.54) | 7 (17.50) | 7 (28.00) | 0.096 |
| | normal | 49 (75.38) | 33 (82.50) | 16 (64.00) | |
| | above normal | 2 (3.08) | 0 (0.00) | 2 (8.00) | |
| PC (%) | M±SD | 96.65±16.45 | 98.22±16.88 | 94.30±15.83 | 0.219 |
| | below normal | 3 (5.00) | 0 (0.00) | 3 (12.50) | 0.030 |
| | normal | 57 (95.00) | 36 (100.00) | 21 (87.50) | |
| AT (%) | M±SD | 106.47±15.87 | 107.32±15.99 | 105.20±15.94 | 0.597 |
| | below normal | 1 (1.67) | 1 (2.78) | 0 (0.00) | 0.712 |
| | normal | 54 (90.00) | 32 (88.89) | 22 (91.67) | |
| | above normal | 5 (8.33) | 3 (8.33) | 2 (8.33) | |

AIS-arterial ischemic stroke, FCA-focal cerebral arteriopathy, APTT-activated partial thromboplastin time, PC-protein C, AT-antitrombin, M-mean value, SD-standard deviation

**Table 4.**
Correlations between lipids and coagulation related parameters in total group of children with AIS

| Lipids | Coagulation related parameters | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | APTT (s) | | Fibrinogen (g/L) | | PC (%) | | AT (%) | |
| | r | p | r | p | r | p | r | p |
| TC (mg/dL) | 0.008 | 0.953 | 0.193 | 0.123 | −0.033 | 0.802 | 0.120 | 0.360 |
| LDL (mg/dL) | 0.017 | 0.899 | 0.055 | 0.663 | −0.005 | 0.968 | 0.183 | 0.163 |
| HDL (mg/dL) | 0.022 | 0.867 | −0.063 | 0.619 | −0.003 | 0.981 | −0.080 | 0.541 |
| Non-HDL (mg/dL) | 0.034 | 0.801 | 0.126 | 0.318 | 0.077 | 0.561 | 0.155 | 0.238 |
| TG (mg/dL) | 0.203 | 0.124 | 0.256 | 0.039 | 0.095 | 0.473 | −0.103 | 0.434 |
| VLDL (mg/dL) | 0.203 | 0.124 | 0.256 | 0.039 | 0.095 | 0.473 | −0.103 | 0.434 |
| TC/HDL | −0.007 | 0.961 | 0.184 | 0.142 | −0.021 | 0.873 | 0.204 | 0.118 |
| LDL/HDL | 0.040 | 0.766 | 0.094 | 0.455 | 0.014 | 0.917 | 0.242 | 0.063 |
| TG/HDL | 0.084 | 0.525 | 0.285 | 0.021 | 0.037 | 0.777 | 0.070 | 0.595 |

AIS-arterial ischemic stroke, FCA-focal cerebral arteriopathy, TC-total cholesterol, LDL-low density lipoprotein, HDL-high density lipoprotein, TG-triglycerides, VLDL-very low density lipoprotein, APTT-activated partial thromboplastin time, PC-protein C, AT-antithrombin, M-mean value, SD-standard deviation

## Discussion

Ischemic stroke in children is a complex, multifactorial and heterogeneous disease. However in many cases no cause of AIS can be identified and, on the other hand, in a great number of patients several risk factors can be established. The most frequent risk factor for pediatric stroke is arteriopathy, which is especially related to the recurrence of AIS. Earlier, vascular abnormalities were related to 60% recurrence rate of AIS while no recurrence was observed in stroke children with normal vascular imaging [4]. The causes for the FCA occurrence in children are not well known and examined. The main predictor for FCA was suggested to be recent upper respiratory infection with the OR of 2.36 [1]. However, it is certainly not the only risk factor. Other factors, including biochemical and genetic ones may also be considered. Undoubtedly, recognition of the levels of various risk factors, which may be involved in the pathogenesis of AIS as well as the correlations between them may help to understand the mechanisms of stroke and also be a contributor for stroke prevention. Therefore, our goal was to analyze whether the lipid and coagulation profiles differentiate children with AIS depending on the presence of FCA. These factors may play important role in the etiology of paediatric AIS. Since arteriopathy is considered as an inflammation state we may conclude that inflammation may also interact with dyslipidemia in the development of AIS in children as it was earlier demonstrated in adults [13]. Inflammation in the central nervous system (CNS) was suggested to be a secondary injury mechanism following ischemic stroke and cytokines and other inflammatory markers may play a key role in the progression of this damage [14]. We observed that stroke subtypes differentiated children with and without FCA. TACI and PACI stroke subtypes were significantly more frequent in analyzed AIS children with FCA whereas in the AIS group without FCA – LACI was the most prevalent. Previously, the difference in plasma levels of some inflammatory mediators was demonstrated in adult patients in dependence of the stroke subtype – cases with cardioembolic subtype had higher levels of these factors while cases with the lacunar subtype – lower [15]. Higher levels of TNF-α and IL-6 were also found to influence infarct volume and poor outcome in adult patients from Spain [16]. In turn, Diao et al. [17] observed, in meta-analysis, that low level of interleukin-10 may be a risk factor for cerebral infarction in India and Croatia. We observed also that the distribution of the number of stroke symptoms was similar in both subgroups, but the number of post-stroke consequences was already significantly different between AIS patients with and without FCA. Only AIS children with FCA had post-stroke seizures. According to study of Fox et al. [18] seizures at the time of stroke are predictors of active post-stroke epilepsy. However, in our study we did not observe such a relation.

We found that mean levels of the analysed lipid parameters (TC, LDL, HDL or TG) as well as TC/HDL, TG/HDL and LDL/HDL ratios did not differentiate pediatric patients with AIS and FCA from those with AIS but without FCA. The levels of all analysed parameters were assessed during the acute phase of ischemic stroke and their mean levels were found to be within the normal range. We observed similar percentages of patients with hypertriglyceridemia (about 40%) in the entire study group and in the analysed subgroups of patients. This result is in agreement with the most recent data of International Pediatric Stroke Study (IPSS) in which 41% of the children with AIS had elevated level of TG [12]. In turn, in our study group about half of the children were dyslipidemic while in IPSS study – 36%. However, in the study of Reuter et al. [19] based on 1243 healthy children and adolescents from Brazil, dyslipidemia was found with 42% prevalence and was more frequent in girls than in boys. When we compared children with AIS to control group published previously [20] we observed that AIS patients had significantly higher levels of TC, LDL and TG and significantly lower level of HDL.

We also did not demonstrated differences in mean values of PC, APTT, AT and fibrinogen depending on the presence of FCA. Interestingly, deficiency of protein C as well as the level of fibrinogen above normal were found only in AIS children without FCA. In our analysis, the only child with antithrombin deficiency had FCA. AT is a strong inhibitor of blood coagulation and through the inhibition of PAI-1 it

promotes fibrinolysis. Its deficiency is the first reported cause of inherited thrombophilia and is a risk factor for venous thromboembolism [21]. The results of meta-analysis of Kenet et al. [22] based on a large number of pediatric patients showed that AT deficiency was associated to a first AIS onset in children (odds ratio (OR) equal to 3.29). The authors found also that children with protein C deficiency had significantly higher risk of AIS occurrence (OR=11.00) [22]. Another coagulation related parameter, APTT which measures the time necessary to generate fibrin from initiation of the intrinsic pathway and its extension indicates a decrease in blood clotting. Previously, in Chinese AIS patients shortened APTT was demonstrated to be an independent risk factor for AIS, stroke severity, as well as neurological worsening after acute stroke [23]. In our study, APTT below normal was more frequent in children without FCA.

Previously, significant increase in fibrinogen, D-dimer, and TG levels but decreased APTT were shown in adult men with AIS when compared to healthy controls [24]. Elevated level of fibrinogen and D-dimer but decreased level of antithrombin was also observed in adult patients with AIS from Sweden [25]. Hyperfibrinogenemia may predict poor outcome since it increased the risk of death within one year after stroke in adult patients [26]. In the study of Swarowska et al. [27] the sustained fibrinogen's level was observed in 17% of AIS patients and was associated with reduced chance of favorable outcome. The authors observed also that patients with sustained fibrinogen's increase had among others higher plasma glucose on admission as well as triglyceride level. In our study we demonstrated similar positive correlation – the higher fibrinogen level the greater are values of TG, VLDL and TG/HDL ratio on average. Earlier positive correlation between fibrinogen and TG was observed in hypertensive Sudanese patients treated with anti-hypertensive drugs [28]. Significant increase in the TG level as well as TG/HDL ratio was also demonstrated in overweight/obese postmenopausal women in the second and the third fibrinogen tertile when compared with the first, the lowest level fibrinogen tertile [29]. In turn, the role of TG in the risk of ischemic stroke seems to be unclear and controversial. Previously, Kisialiou et al. [30] observed that normal-high levels of TG were associated with smaller infarct size. In the large prospective study including 1529 adult patients with ischemic stroke, 4% of men and 1% of women had 3 – and 4-fold higher risk of ischemic stroke, respectively when nonfasting level of TG was ≥443mg/dL [31].

Since pediatric AIS is a rare disease and our study was performed in a single medical center, the analysed sample size is small. It is worth to conduct such analyses in larger group of patients and in collaboration with other hospitals. There is also lack of comparison between our group of AIS cases and healthy control group. However, the advantage of this study is a great number of analysed risk factors.

In conclusion, FCA is associated with stroke subtypes as well as the presence of post-stroke consequences however lipid profiles and levels of selected coagulation related parameters analyzed in the study did not differentiate children with AIS and FCA from children with AIS but without FCA.

## Conflict of Interest Statement

The authors declare no conflict of interest.

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