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Original Article

Appraisal of the Role of Apelin and Visfatin in Ischemic Heart Patients

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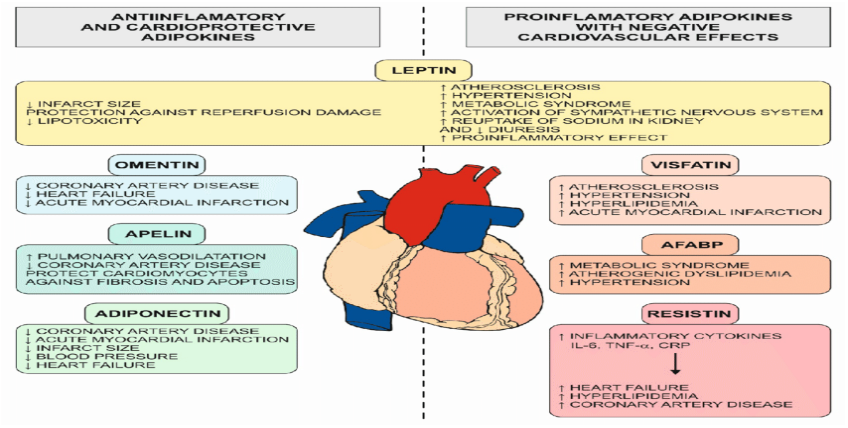
ABSTRACT

The disease of the ischemic heart is still a severe burden on individuals and healthcare resources all over the world. Flow-limiting obstruction in large–medium-sized coronary arteries is usually linked with atherosclerotic plaque. Aim of the study: To assess visfatin, apelin Vit-D_3, and lipid profile concentration in thrombus and hypertension patients. The current study involved 35 ischemic heart disease solely patients (group 1), 33 with ischemic heart disease plus hypertension patients (group2), and 35 as healthy control (group3). Apelin, visfatin, troponin, Vit-D_3, and lipid profile levels were evaluated. In the cases of thrombus with hypertension and thrombus only patients, blood apelin, visfatin, triglyceride, total cholesterol, LDL, and VLDL levels were considerably higher, and blood Vit-D_3 and HDL levels were considerably lower than in the healthy controls group. The findings of this study suggest that serum apelin, visfatin, troponin, and lipid profile may not only do pathogenicity a part in the occurrence of the disease but also play a role in the severity of IHD. More than apelin, the circulating amount of visfatin is a particular indicator for IHD.

GRAPHICAL ABSTRACT



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Introduction

Ischemic heart disease (IHD), commonly referred to as cardiovascular disease, is a collection of clinical syndromes defined by myocardial ischemia, or a supply-demand imbalance in the heart muscle. Because the significant pathophysiologic defect in the ischemic myocardium is inadequate perfusion, ischemia is linked to an insufficient oxygen supply, reduced food availability and inefficient clearance of metabolic end products. Heart difficulties induced by suffocating heart (coronary) arteries that supply blood to the cardiac muscle are referred to as coronary heart disease (CHD). Although a blood clot or blood artery constriction can cause narrowing, plaque formation, commonly known as atherosclerosis, is the most typical cause [1].

Visfatin is a multifunctional adipocytokine that functions as a growth factor and a cytokine. It is significantly concentrated in visceral fat. Visfatin is involved in several metabolic and stress reactions and cellular energy consumption [2]. Nonetheless, visfatin is active in increasing vascular inflammation, atherosclerosis formation and progression, and plaque destabilization, in addition to being a surrogate clinical sign [3]. Although the results are mixed, visfatin has lately been examined as a potential novel marker for detecting stages of essential hypertension in older adults [4].

Apelin is a newly discovered adipocytokine produced by white adipose tissue that functions as a high-affinity endogenous ligand for the G-protein coupled receptor. It is implicated in cardiovascular and fluid homeostasis, angiogenesis, and apoptosis inhibition [5]. Apelin is a ligand for the APJ receptor, a peptide produced and released by adipocytes that circulate in the bloodstream [6]. APJ and apelin mRNA are found in various tissues, including the kidneys and cardiovascular regions [7]. Apelin signaling has been linked to the control of vascular tone, cardiac contractility, and fluid balance in recent research [8].

In the cardiovascular system, it has been discovered in endothelial cells of major channel arteries, coronary vessels, and the endocardium of the right atrium [9]. Cardiac troponin is a biomarker for myocardial damage that is both specific and sensitive. They are the most often used serologic assays to assess individuals with a suspected acute myocardial infarction [10]. The biological actions of distinct cardiac troponin fragments may differ. Low amounts of both cTnT and cTnI circulate in individuals with stable ischemic heart disease (SIHD), which may be identified more easily with high-sensitivity cardiac troponin tests, and are perhaps connected to the CAD or comorbidities that contribute to CAD [11]. As a result, this study aims to evaluate apelin, visfatin, troponin, and lipid profiles in individuals with heart disease and hypertension. The goal of this study is to add to that amount of information.

Materials and Methods

Patients

The study included 35 patients with ischemic heart disease, 33 patients with ischemic heart disease plus hypertension, and a group of 35 reportedly healthy individuals who were admitted to Al-Salam Teaching Hospital in Mosul, Iraq, between February 2021 and January 2022.

Sampling

All patients and healthy controls had blood samples collected. The samples were then centrifuged for ten minutes at 3000 rpm until being stored till they were analyzed.

Analytical biochemistry

The commercial enzyme-linked immunosorbent assay was used to assess serum apelin, visfatin, and troponin (IBL International GmbH, Germany). The VIDAS automated immunoassay platform assessed vitamin D using an enzyme-linked fluorescence assay (ELFA) with VIDAS 25-OH vitamin D total testing kits (Biomerieux, France). The Abbott diagnostics division, Abbott laboratories AbbottPark, IL, was used to assess the serum lipid profile as cholesterol, triglycerides, HDL-C, and HDL-C levels (ARCHITECT c Systems and the AERO SET System).

Partial Purification of Apelin and Visfatin

Various quantities of ethanol (45-90 percent v/v) were added to each supernatant component and mixed gently at 4 °C under gentle stirring. After that, the samples were maintained at 4 °C for 24 hours without being disturbed.

Ammonium sulfate precipitation

Gradually added solid ammonium sulfate was till 20 percent saturation was reached. In an ice bath, ammonium sulfate was added with constant moderate stirring and held at 4 °C overnight Centrifugation at 5000 rpm for 1 hour at 4 °C was used to remove the precipitated protein. The supernatant was treated with ammonium sulfate to obtain an 80% saturation level. For one hour, a centrifuge at 5000 rpm at 4 °C was used to remove the precipitated protein. The precipitated protein was dissolved in 0.1 M sodium acetate buffer pH 5 in a 25 mL volume [12].

Dialysis

The precipitate produced following treatment with ammonium sulfate (80% saturation) was dialyzed overnight at 4 °C±1 under agitation against 0.1 M sodium acetate buffer pH 5 in a cellulose membrane dialysis tube, with the buffer changed every four hours. Apelin and visfatin activity and protein content were evaluated in the dialyzed hormones solution [13]. Mix a small amount of the dialyzing fluid with an equal amount of saturated barium chloride solution to check for sulfate. The dialysis is deemed complete if the mixture does not get hazy (Figure 1) [14]. The dialysis cellulose tubing membrane was prepared according to the instructions provided by Sigma-Aldrich Chemical Company in Germany.

Gel filtration chromatography

The partly purified protein preparation was loaded to a Gel filtration/Sephadex G-100 that had been pre-equilibrated with 0.1 M sodium acetate buffer pH 5 and eluted with the same buffer at a flow rate of 0.3 mL per minute. Both the protein content of apelin and the activity of visfatin was evaluated using 4 mL fractions [12]. At 280 nm, the protein concentration of the eluent was determined spectrophotometrically [15].

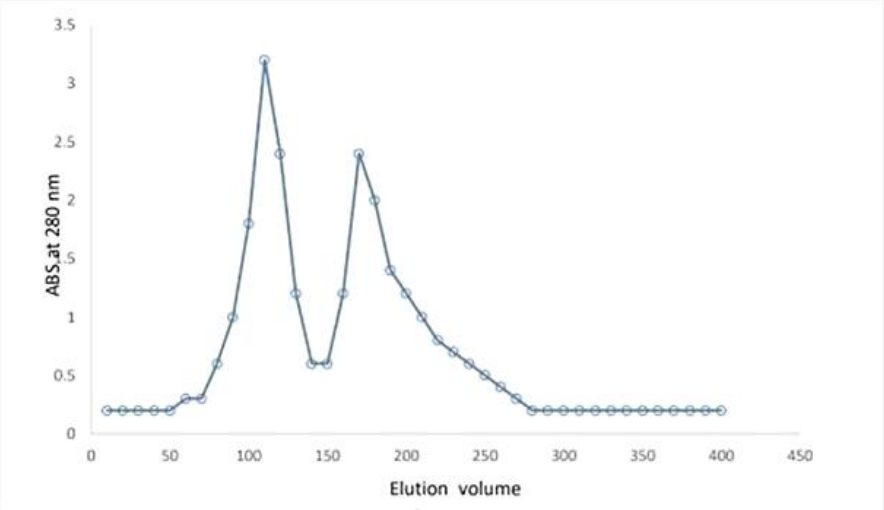

Figure 1: Partial purification of Apelin and Visfatin from serum of ischemic heart patients by gel chromatography using sephadex G-100

Statistical analysis

All data is provided as a mean standard deviation. The data were analyzed using the Student's t-test. At $P < 0.05$, values were considered significant.

Results and Discussion

Table 1 shows the cholesterol, triglyceride, HDL, LDL, and VLDL among study groups (thrombus patients, thrombus with hypertension patients, and healthy controls). The results reveal significantly higher mean of cholesterol, T.G., LDL, and VLDL in patients with thrombus and hypertension (233.214 ± 233.214, 291.846 ± 34.819, 149.406 ± 51.801 and 58.361 ± 6.977) than thrombus patients (210.818 ± 43.596, 245.134 ± 47.811, 130.670 ± 44.213 and 48.761 ±

9.552) respectively. In contrast, the results show that HDL and Vit-D_3 levels were low in patients with thrombus and hypertension (25.664 ± 2.990, 10.975 ± 1.359) than in thrombus patients (31.256 ± 3.325, 14.106 ± 1.820) respectively (Table 1). According to gender, the results show that cholesterol, LDL, and Vit-D_3 levels are higher in males (278.284 ± 22.547, 197.412 ± 27.558, 11.861 ± 0.895) respectively than in females (194.153 ± 26.080, 107.801 ± 23.013, 10.206 ± 1.230). While the results of T.G, HDL, and VLDL levels were higher in females (293.966 ± 45.426, 28.013 ± 1.391, 58.778 ± 9.106) than in males (289.400 ± 17.558, 22.953 ± 1.731, 57.880 ± 3.511) respectively in patients with thrombus and hypertension. See Table 1. in patients with thrombus only, the results show that cholesterol, HDL, and LDL levels are higher in females (217.593 ± 42.981, 33.346 ± 2.119, and 141.874 ± 41.434) respectively than in males (204.841 ± 44.554, 22.953 ± 1.731, 120.783 ± 45.428). While the results of T.G and VLDL levels were higher in males (265.411 ± 43.433, 53.063 ± 8.678) than in females (222.153 ± 42.901, 43.885 ± 8.247) respectively (Table 1).

Table 1: levels of lipid profile parameters among study groups according to gender

Parameters		Cholesterol (mg/dl)			T.G (mg/dl)			HDL (mg/dl)		
Study groups		Mean	Std. Deviation	No.	Mean	Std. Deviation	No.	Mean	Std. Deviation	No.
Healthy controls	Males	166.866	30.106	30	137.460	27.264	30	37.786	9.500	30
	Females	174.253	25.156	30	133.813	30.706	30	41.286	5.993	30
	Total	170.560	27.757	60	135.636	28.847	60	39.536	8.070	60
Thrombus patients	Males	204.841*	44.554	32	265.411*	43.433	32	29.411*	3.128	32
	Females	217.593*	42.981	30	222.153*	42.901	30	33.346*	2.119	30
	Total	210.818*	43.596	62	245.134*	47.811	62	31.256*	3.325	62
Thrombus in Hypertension patients	Males	278.284*	22.547	28	289.400*	17.558	28	22.953*	1.731	28
	Females	194.153*	26.080	31	293.966*	45.426	31	28.013*	1.391	31
	Total	233.214*	233.214	59	291.846*	34.819	59	25.664*	2.990	59
Parameters		LDL (mg/dl)			VLDL (mg/dl)			Vit-D3 (ng/Ml)		
Study groups		Mean	Std. Deviation	No.	Mean	Std. Deviation	No.	Mean	Std. Deviation	No.
Healthy controls	Males	101.588	27.109	30	27.492	5.452	30	20.660	1.867	30
	Females	106.100	23.241	30	26.753	6.150	30	15.480	2.957	30
	Total	103.844	25.137	60	27.122	5.774	60	18.070	3.582	60
Thrombus patients	Males	120.783*	45.428	32	53.063*	8.678	32	15.317*	1.036	32
	Females	141.874*	41.434	30	43.885*	8.247	30	12.733*	1.518	30
	Total	130.670*	44.213	62	48.761*	9.552	62	14.106*	1.820	62
Thrombus in Hypertension patients	Males	197.412*	27.558	28	57.880*	3.511	28	11.861*	0.895	28
	Females	107.801*	23.013	31	58.778*	9.106	31	10.206*	1.230	31
	Total	149.406*	51.801	59	58.361*	6.977	59	10.975*	1.359	59

** mean this significant differences at p ≤ 0.05*

Table 2 shows cholesterol, T.G, HDL, LDL, and VLDL among study groups according to age groups. According to data in this study, the results of cholesterol, T.G, LDL, and VLDL levels in patients with thrombus only showed the highest within the age group 50- 60 years (229.833 ± 51.673, 255.291 ± 29.324, 149.351 ± 50.344, 50.673 ± 5.571) followed by 60-70 years (217.490 ± 35.437,239.909 ± 62.584, 136.043 ± 38.704, 47.974 ± 12.509) respectively while the lowest levels were showed with age group 40-50 years (177.311 ± 16.042, 237.977 ± 50.293, 99.193 ± 23.228, 47.173 ± 10.300). In contrast, the HDL level was higher inthe age group 50-60 years (31.691 ± 1.270), followed by the age group 40-50 years (31.188 ± 2.812), while the lower level was (30.836 ± 5.075) in the age group 60-70 years. In contrast, the Vit-D_3 level was higher in the age group 40-50 years (15.222 ± 1.354), followed by the age group 50-60 years (14.216 ± 1.661), while the lower level was (13.072 ± 1.859) in the age group 60-70 years (Table 2).

Table 2: levels of lipid profile parameters among study groups according to age groups

Parameters		Cholesterol (mg/dl)			T.G (mg/dl)			HDL (mg/dl)		
Study groups	Age groups (years)	Mean	Std. Deviation	No.	Mean	Std. Deviation	No.	Mean	Std. Deviation	No.
Healthy controls	40-50	166.350	29.038	20	119.940	33.815	20	42.120	7.265	20
	50-60	162.240	33.194	21	140.220	29.409	21	39.770	11.051	21
	60-70	183.090	13.806	19	146.750	12.816	19	36.720	3.452	19
Thrombus patients	40-50	177.311	16.042	19	237.977*	50.293	19	31.188*	2.812	19
	50-60	229.833*	51.673	22	255.291*	29.324	22	31.691*	1.270	22
	60-70	217.490*	35.437	31	239.909*	62.584	31	30.836*	5.075	31
Thrombus inHypertension patients	40-50	224.142*	36.471	17	292.657*	39.451	17	26.314*	2.138	17
	50-60	229.883*	52.013	22	293.550*	28.839	22	25.533*	2.858	22
	60-70	244.711*	56.211	20	288.944*	42.029	20	25.333*	3.872	20
Parameters		LDL (mg/dl)			VLDL (mg/dl)			Vit-D3 (ng/ml)		
Study groups	Age groups (years)	Mean	Std. Deviation	No.	Mean	Std. Deviation	No.	Mean	Std. Deviation	No.
Healthy controls	40-50	100.172	27.903	20	23.988	6.763	20	20.840	2.456	20
	50-60	94.426	27.350	21	28.044	5.881	21	17.410	3.497	21
	60-70	116.934	12.152	19	29.336	2.610	19	15.960	2.892	19
Thrombus patients	40-50	99.193*	23.228	19	47.173*	10.300	19	15.222*	1.354	19
	50-60	149.351*	50.344	22	50.673*	5.571	22	14.216*	1.661	22
	60-70	136.043*	38.704	31	47.974*	12.509	31	13.072*	1.859	31
Thrombus inHypertension patients	40-50	137.205*	35.554	17	58.522*	7.907	17	12.257*	1.004	17
	50-60	147.100*	56.249	22	58.700*	5.781	22	10.808*	1.322	22
	60-70	161.971*	58.669	20	57.784*	8.419	20	10.200*	0.959	20

** mean this significant differences at p ≤ 0.05*

In patients with thrombus and hypertension, the results show that cholesterol and LDL levels were higher in the age group 60-70 years (244.711 ± 56.211, 161.971 ± 58.669), respectively. Followed by the age group 50-60 years (229.883 ± 52.013, 147.100 ± 56.249), respectively while the lower level in the age group 40-50 years (224.142 ± 36.471, 137.205 ± 35.554) respectively. With T.G the results show that T.G and VLDL levels were higher in the age group 50-60 years (293.550 ± 28.839, 58.700 ± 5.781) followed by the age group 40-50 years (292.657 ± 39.451, 58.522 ±7.907)

respectively. In contrast, the lower level was (288.944 ± 42.029, 57.784 ± 8.419) respectively, with the age group 60-70 years. With HDL and Vit-D_3, the results show that HDL and Vit-D_3 levels were higher in the age group 40-50 years (26.314 ± 2.138, 12.257 ± 1.004) followed by 50-60 years (25.533 ± 2.858, 10.808 ± 1.322) respectively and 60-70 years (25.333 ± 3.872, 10.200 ± 0.959) respectively Table 2. The results of the statistical analysis showed significant differences P ≤ 0.05.

Table 3 summarized the results of visfatin ng\mL, Apelin ng\mL, and troponin (ng\mL) among thrombus patients, thrombus with hypertension patients, and healthy controls groups. The results showed a significantly higher mean of visfatin in patients with thrombus and hypertension (70.250 ± 18.056) than in thrombus patients (50.875 ± 16.505) compared to healthy controls (10.136 ± 2.188).

Also, the results revealed that apelin was higher in patients with thrombus only (251.406 ± 23.714) than in patients with thrombus and hypertension (200.107 ± 6.854) compared to healthy controls (158.066 ± 9.300). In contrast, the results show that troponin level was higher in patients with thrombus and hypertension (7.214 ± 2.803) than in thrombus patients (3.956 ± 1.328) compared to healthy controls (0.996 ± 0.148) (Table 3).

According to gender, the results show that visfatin, apelin, and troponin levels were higher in males (64.764 ± 7.611, 267.352 ± 21.595, 4.382 ± 0.600) than in females (35.133 ± 6.104, 233.333 ± 7.316, 3.473 ±1.739) respectively in patients with thrombus only. Furthermore, the results showed that visfatin, apelin, and troponin levels were higher in males (88.000 ± 4.546, 204.076 ± 3.925, 9.153 ± 1.179) than females (54.866 ± 8.061, 196.666 ± 7.077, 5.533 ± 2.729) respectively in patients with thrombus and hypertension Table 3.

Table 4 shows the results of visfatin, apelin, and Vit-D_3 levels among study groups based on age groupings. According to the findings of this investigation, the outcomes of visfatin, apelin, and troponin levels in patients with thrombus only showed the highest within the age group 60- 70 years (57.636 ± 16.268, 263.090 ± 27.046, 4.918 ± 1.368) followed by 50-60 years (50.916 ± 16.334, 253.583 ± 22.199, 3.750 ± 0.811) respectively. In contrast, the lower levels were shown in the age group 40-50 years (42.555 ± 14.740, 234.222 ± 7.758, 3.055 ± 1.157), respectively Table 4. In patients with thrombus and hypertension, the results show that visfatin level was higher in the age group 50-60 years (74.500 ± 16.714) followed by age group 60-70 years (72.333 ± 16.000) while the lower level in the age group 40-50 years (60.285 ± 21.336).

With apelin, the results show that apelin level was higher in the age group 40-50 years (202.714 ± 8.957), followed by the age group 60-70 years (200.222 ± 6.666). in contrast, the lower level was (198.500 ± 5.664), with the age group 50-60. With troponin, the results show that troponin levels were higher in the age group 60-70 years (8.944 ± 0.845) followed by 50-60 years and 40-50 years (7.416 ± 2.457, 4.642 ± 3.327), respectively (Table 4). The statistical analysis revealed significant differences with a P value of < 0.05.

Table 5 shows the results regarding the purification of apelinat different phases of purification. The total specifics Con. of apelin (2.61 pg/mg) with 100% recovery of apelin activities via the precipitation of ammonium sulfate. Table 5also shows that the proteinous precipitate solution step resulted in 2.5-fold purification with 93.77% recovery of apelin activity. While the other use of gel filtration /Sephadex G-100 increased the protein purity by 80.64 (12.5-fold) purification above obtained proteinous precipitate solution, with 71.77% recovery of apelin activity (Table 5).

Table 6 shows the results of the purification of visfatin at different purification steps. The Total specific Con. of visfatin (0.24 pg/mg) with 100% recovery of visfatin activity via the precipitation of ammonium sulfate. The results in Table 6also show that the proteinous precipitate solution step resulted in 2.25-fold purification with 84.88% recovery of visfatin activity.

Table 3: levels of Visfatin, apelin, and Vit-D_3 parameters among study groups according to gender

Parameters		Visfatin (ng\mL)			Apelin (ng\mL)			Troponin (ng\mL)		
Study groups		Mean	Std. Deviation	No.	Mean	Std. Deviation	No.	Mean	Std. Deviation	No.
Healthy controls	Males	11.766	0.572	30	164.400	5.353	30	1.066	0.132	30
	Females	8.506	1.979	30	151.733	8.021	30	0.926	0.131	30
	Total	10.136	2.188	60	158.066	9.300	60	0.996	0.148	60
Thrombus patients	Males	64.764*	7.611	32	267.352*	21.595	32	4.382*	0.600	32
	Females	35.133*	6.104	30	233.333*	7.316	30	3.473*	1.739	30
	Total	50.875*	16.505	62	251.406*	23.714	62	3.956*	1.328	62
Thrombus inHypertension patients	Males	88.000*	4.546	28	204.076*	3.925	28	9.153*	1.179	28
	Females	54.866*	8.061	31	196.666*	7.077	31	5.533*	2.729	31
	Total	70.250*	18.056	59	200.107*	6.854	59	7.214*	2.803	59

** mean this significant differences at p ≤ 0.05*

Table 4: levels of Visfatin, Apelin, and Vit-D_3 parameters among study groups according to age groups

Parameters		Visfatin (ng\mL)			Apelin (ng\mL)			Troponin (ng\mL)		
Study groups	Age groups (years)	Mean	Std. Deviation	No.	Mean	Std. Deviation	No.	Mean	Std. Deviation	No.
Healthy controls	40-50	9.800	2.190	20	149.900	8.110	20	0.940	0.146	20
	50-60	10.520	2.250	21	161.300	7.678	21	0.980	0.143	21
	60-70	10.090	2.174	19	163.000	6.087	19	1.070	0.130	19
Thrombus patients	40-50	42.555*	14.740	19	234.222*	7.758	19	3.055*	1.157	19
	50-60	50.916*	16.334	22	253.583*	22.199	22	3.750*	0.811	22
	60-70	57.636*	16.268	31	263.090*	27.046	31	4.918*	1.368	31
Thrombus inHypertension patients	40-50	60.285*	21.336	17	202.714*	8.957	17	4.642*	3.327	17
	50-60	74.500*	16.714	22	198.500*	5.664	22	7.416*	2.457	22
	60-70	72.333*	16.000	20	200.222*	6.666	20	8.944*	0.845	20

** mean this significant differences at p< 0.05*

Table 5: Partial purification of apelin inHuman Serum

Purification Steps	Volume (ml)	Total protein (mg)	Total con. of apelin (pg)	Total specific Con. of apelin (pg/mg)	Recovery %	Times of purification
Serum	10	80	209	2.61	100	1
Proteinous precipitate solution	5	30.5	196	6.43	93.77	2.46
Dialysis	8	20.4	180	8.82	86.12	3.37
Gel filtration /Sephadex G-100 (peak A) after Lyophilizer	4	1.86	150	80.64	71.77	30.90

Table 6: Partial purification of Visfatin in Human Serum

Purification Steps	Volume (ml)	Total protein (mg)	Total con. of visfatin (pg)	Total specific Con. of visfatin (pg/mg)	Recovery %	Times of purification
Serum	10	80	19.32	0.24	100	1
Proteinous precipitate solution	5	30.5	16.4	0.54	84.88	2.24
Dialysis	8	20.4	14.2	0.69	73.49	2.88
Gel filtration /Sephadex G-100 (peak B) after Lyophilizer	6	2.79	12.6	4.52	65.21	18.83

While the other use of gel filtration /Sephadex G-100 purification step increased the enzyme purity by 4.52 (8.37 fold) purification above obtained proteinous precipitate solution, with 65.21% recovery of visfatin activity (Table 6).

To our factual information, that is the first research to examine the serum levels of apelin and visfatin in patients with thrombus + hypertension with those with thrombus only. The study's key findings show that groups with thrombus + hypertension, as well as thrombus solely, have a positive relationship with apelin and, with visfatin serum levels. These associations are impacted by, tobacco smoking, BMI, and lipids state.

According to our data, the levels of TC, TAG, LDL-C, and VLDL-C were markedly increased in thrombus and hypertension. The importance of lipid profiles in the course of CVD has been proven in some research. Increases in triglyceride (TG) and total cholesterol (TC) levels may impact the constriction and abstraction of arteries in the heart, both of which are linked to the risk of cardiovascular disease (CVD) [16, 17]. Furthermore, increased low-density lipoprotein cholesterol levels (LDL-C) may cause arteriosclerosis by accumulating LDL-C in the artery's intima-media, stimulating thrombocytopoiesis [18]. On the other hand, increased high-density lipoprotein cholesterol (HDL-C) levels may lower the risk of cardiovascular disease. As a result, those with high HDL-C and low non-HDL-C may be less likely to develop CVD. The Framingham finding convincingly proved the link between high cholesterol and coronary heart disease [19]. Evidence from epidemiologic research shows that having low HDL-C and high triglyceride levels is a substantial risk factor for CHD and that individuals with low HDL-C and high triglyceride levels had the greatest rate of severe coronary events [20]. Although whether an elevated level of small dense LDL is an independent risk factor is debatable, it is linked to an increased risk of CHD [21]. In Europeans and Asians, serum cholesterol is a well-established CHD risk factor.

Plasma LDL-C levels are key CHD risk factors, and treatment with LDL-C medications has decreased CHD risk, which is proportional to a drop in LDL-C levels [22]. In the current investigation, VITD levels were lower in the thrombus with hypertension group and the thrombus alone group. This is similar to another study that found an association between low Vit D levels in the body and an increased risk of IHD [23, 24]. Vitamin D has recently gotten much attention because of its possible cardioprotective qualities, and it has become a hot issue in the clinical and academic areas. Greater elevations have a higher prevalence of CHD and hyperlipidemia, which has been environmentally linked to less sunshine [25]. Other studies have found that people who get less UV radiation have lower vitamin D levels and an increased risk of CHD, myocardial infarction, and hypertension [26]. Lower levels of vitamin D in the peripheral blood have also related to an enhanced probability of serious cardiac mortality [27]. Compared to healthy individuals, the level of apelin was considerably higher in the thrombus with hypertension group and the group with thrombus only. Similar research on Egyptian

individuals with Ischemic heart disease (IHD) has resulted in similar results [28]. By interacting with the endogenous ligand of the G-protein coupled receptor, apelin, which is produced by endothelial cells, affects most types of cardiac cells, including myocytes, smooth muscle cells, and fibroblasts, via autocrine and paracrine routes. Collagen is produced by replacement fibroblast cells that are converted into contractile myofibroblasts to replace necrotic or apoptotic myocytes after myocardial infarction [29].

Our study findings corroborated Abd-Elbaky*et al*. [30] in Egyptian CVD patients. Apelin has been discovered to perform a cardioprotective role in the disease-causing remodeling process. Its compensatory up-regulation at the commencement of cardiac stress, observed in patients [31], is considered the case. These findings appear to be in line with the current literature. As previously indicated, in a prior study conducted by our team, young healthy kids of hypertension patients had higher office BP and lower apelin levels than comparable offspring of normotensive persons [32]. According to a recent study by Guneset *al*., visfatin levels are considerably greater in prehypertensive patients. Furthermore, the scientists discovered a powerfully positive relationship between blood pressure and visfatin in the study's population of 76 middle-aged normotensives and hypertensives [33]. However, its eventual decay/normalization might contribute to cardiac remodeling**,** on the contrary [34]. Visfatin is linked to a pro-inflammatory condition that can lead to various pathologic alterations, including atherosclerosis. The current study revealed the concentration of blood visfatin to be considerably lower in individuals with AMI. Visfatin is a pro-inflammatory cytokine found in foam cell macrophages inside unsettled tabular atherosclerotic lesions and is thought to have a role in plaque instability, according to Dahl *et al*. [35]. another studyhas shown that visfatin, as a potent catalyst leading to atherosclerotic plaque instability by activating NF-KB. Furthermore, visfatin is engaged in endothelial cells, which produces atherosclerosis and plays a significant role in various cardiovascular diseases [36].

The findings demonstrated a consistent and substantial link between troponin levels and the risk of death in IHD patients. Because of the strong link between troponin concentration and the risk of myocardial infarction, stroke, heart failure, death from cardiovascular causes, and death from any cause in patients with stable ischemic heart disease, high-sensitivity cardiac troponin concentration appears to be a powerful prognostic marker in patients with stable ischemic heart disease. Chronic small-vessel ischemia, hypertension, metabolic abnormalities, and renal dysfunction, which cause troponin release in patients with stable ischemic heart disease, appear to be less responsive to epicardial coronary revascularization than the ischemic injury causes troponin release in patients with acute coronary syndromes [37, 38]. The adducts: $CuAV_2$ and $CuA\text{-}ClV_2$ formed in DMF media are reduced by activated zinc powder and followed by absorption spectroscopy. The reduction of $V_2^{2+}.2PF_6^-$ moieties afforded the π-dimerized viologen radicals $V_2^{2\bullet}$ within the structures of the adducts: $CuAV_2$ and $CuA\text{-}ClV_2$ themselves.

Conclusions

The findings of this study revealed that the lipid profile, apelin, visfatin, and Vit-D_3 levels in patients with CHD might influence the course of IHD, all-cause mortality, and cardiac death. To study the secondary prevention of major cardiovascular events and death, further large-scale prospective studies focusing on individuals with specific features should be done.

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Authors' contributions

All authors contributed to data analysis, drafting, and revising of the paper and agreed to be responsible for all the aspects of this work.

Conflict of Interest

The author declared that they have no conflict of interest.

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