







regression analysis were used for comparison of data as appropriate. A p value < 0.05 was considered statistically significant.

### RESULTS

Clinical characteristics of patients are summarized in Table 1. Age, hypertension, systolic blood pressure (BP), diastolic BP, heart rate, PP, PPI, diabetes mellitus, dyslipidemia, glucose, creatinine, LDL cholesterol were significantly higher in ischemic stroke patients than control group (p < 0.05). PON-1 activity and HDL cholesterol were significantly lower in ischemic stroke patients than control group (p < 0.05).

**Table I:** Clinical characteristics of patients.

Variables	Group 1 (Ischemic Stroke) n=46	Group 2 (Control Group) n=32	p Value
Age (years)	68.5±13.4	44.1±18.6	0.003
Gender (F/M), n	27 / 19	17 / 15	0.234
Hypertension, n %	29 (65%)	6 (18%)	0.005
SBP (mmHg)	158.4 ± 17.5	124.3 ± 13.6	0.037
DBP (mmHg)	97.1 ± 10.6	74.2 ± 9.3	0.032
Heart Rate (bpm)	117.5 ± 17.2	83.5 ± 12.3	0.022
PP, mm-Hg	60.3±16.5	44.6±12.7	0.033
PPI	0.471±0.072	0.423±0.048	0.041
Diabetes Mellitus, n %	14 (30 %)	2 (6 %)	0.007
Smoking, n %	7 (16 %)	3 (10 %)	0.583
Dyslipidemia, n %	11 (24%)	0 (0 %)	0.004
Glucose (mg/dl)	165.3 ±35.6	103.4 ± 24.3	0.029
HbA1c	7.8 ± 2.1	6.3 ± 1.5	0.043
Creatinine (mg/dL)	1.6±0.5	0.9±0.3	0.037
PON-1 activity	417.7±79.7	432.3 ± 92.0	0.045
LDL cholesterol (mg/dL)	142.1±29.5	108.3±17.2	0.042
HDL cholesterol (mg/dL)	34.5±8.7	42.6±9.8	0.045

F:Female, M:Male, SBP: Systolic Blood Pressure, DBP: Diastolic Blood Pressure, PP: Pulse Pressure, PPI: Pulse Pressure Index, PON1: Paraoxonase 1, LDL: Low Density Lipoprotein, HDL: High Density Lipoprotein.

Systolic blood pressure (BP), diastolic BP, heart rate, PP, PPI were significantly higher in ischemic stroke patients than control group (p < 0.05).

Glucose, creatinine, LDL cholesterol levels were significantly higher in ischemic stroke patients than control group (p < 0.05). PON-1 activity and HDL cholesterol were significantly lower in ischemic stroke patients than control group (p < 0.05).

### Echocardiographic Findings

Echocardiographic findings are summarized in Table 2. LV septal thickness, LV diastolic diameter, LV posterior wall thickness, and E/e' values were significantly higher in Group 1 patients than in Group 2 patients (p < 0.05). LVEF was significantly lower in Group 1 patients than in Group 2 patients

(p < 0.05).

**Table II:** Echocardiographic parameters of patients.

Variables	Group 1 (Ischemic Stroke) n=46	Group 2 (Control Group) n=32	p Value
LV septal thickness, mm	11.8±1.2	10.6±0.9	0.029
LVdD (mm)	53.4±5.9	48.7±4.5	0.042
LV posterior Wall thickness, mm	11.2±1.1	10.4±0.9	0.037
LVDs (mm)	42.4±3.9	39.1±3.7	0.276
LAD (mm)	41.7±3.8	38.3±3.5	0.573
RAD (mm)	33.7±3.2	31.5±2.8	0.563
RVDd (mm)	29.6±2.3	28.1 ± 2.4	0.274
LVEF (%)	52.3±5.8	59.7±5.2	0.042
E/e'	10.1±3.7	7.5 ±2.96	0.026

LV: Left Ventricle, LVdD: Left ventricular diastolic diameter, LVDs: Left ventricular systolic diameter, LAD: Left atrial diameter, RAD: Right atrial diameter, RVDd: Right ventricular diastolic diameter, LVEF: Left ventricular ejection fraction.

Correlation analysis was performed to investigate the relationship between PPI and clinical parameters. It showed a weak negative

correlation between the PPI and LVEF, PON. In addition, there was a positive correlation between the PPI and E/e', age, heart rate, SBP (Table 3). Logistic regression analysis was performed to identify the potential predictors for PPI. Results of the multivariate analysis revealed that age, SBP, LVEF, PON and heart rate were a powerful predictor of PPI. Also, PON is independent predictor of PPI (Table 4).

**Table III:** Correlation of patients' characteristics and pulse pressure index.

Parameters	Pearson's correlation coefficient (r value)	p Value
LVEF	-0.427	0.042
E/e'	0.329	0.032
PON	-0.413	0.041
Age	0.472	0.039
SBP	0.425	0.040
Heart rate	0.234	0.046

LVEF: Left ventricular ejection fraction, PON: Paraoxonase, SBP: Systolic Blood Pressure.

**Table IV:** Multivariate logistic regression analysis between PPI and clinical parameters.

Parameters	OR	95 % CI	p Value
SBP	0.615	0.517-0.792	0.032
LVEF	0.835	0.770-0.920	0.028
PON	0.469	0.314-0.659	0.043
Age	0.426	0.248-0.752	0.040
Heart rate	0.397	0.213-0.654	0.043

SBP: Systolic Blood pressure, PON: Paraoxonase, LVEF: Left ventricular ejection fraction.

## DISCUSSION

Acute stroke is identified as one of the significant reasons of mortality and morbidity<sup>12</sup>. Stroke is a multifactorial disease. This may account why the incidence of acute stroke demonstrates racial and regional variations. There is a proof for ROR relevance in pathogenesis of a lot of diseases, with a specific point on those related to atherosclerosis, such as diabetes, cardiovascular disease, acute stroke, and chronic renal diseases. PON1 is a calcium-dependent glycoprotein. PON1 exerts

lactonase and peroxidase activities. These enzymatic activities are important in neurological diseases associated with oxidative stress<sup>13</sup>. Shenhar TS et al found that PON1 activity was inversely correlates with cerebrovascular atherosclerosis<sup>14</sup>. Strokes are associated with changes in serum PON1 activity. The present study is the first study in the literature that evaluates the relationship between PON-1 activity and PPI in acute ischemic stroke patients. The main finding of our study is that PON-1 activity is significantly decreased in acute ischemic stroke patients than in control subjects. Also, Kim NS et al reported that PON1 enzyme activity is substantially reduced in ischemic stroke patients compared to healthy controls<sup>1</sup>. Demirdogen et al. demonstrated that reduced PON1 activities of acute ischemic stroke patients were lower than those of control subjects<sup>15</sup>. Liu et al. coordinated a meta-analysis of PON1 genetic polymorphisms and acute ischemic stroke. The R allele or RR genotype of PON1 Q192R polymorphism had an increased risk for ischemic stroke in the general population<sup>16</sup>. In the opinion of Wannamethee et al., low HDL-C value is a significant risk factor for the development of stroke<sup>17</sup>. In our study, we found that HDL is significantly lower in acute ischemic stroke patients than in healthy controls. Also, we found that LDL cholesterol was significantly higher in acute ischemic stroke patients than in healthy controls.

Acute stroke is characterized by profound autonomic dysregulation, including alterations in the autonomic reflex pathways, central autonomic neuroanatomical sites and hormonal factors. According to prior investigations on BP changes during the early period of stroke, there is much more higher increasing of SBP than DBP during the acute stroke<sup>18</sup>. Acute stress response to stroke events, increased sympathetic tone, and compensatory response to cerebral ischemia might account these evidences<sup>19</sup>. As a result, an increase of PP could have occurred if

there was more marked elevation of SBP than DBP during acute ischemic stroke period. In this study, we found that SBP, DBP, heart rate, PP, PPI were significantly higher in acute ischemic stroke patients than in healthy controls. Lee KJ et al suggested that PP when calculated in the early period of acute ischemic stroke has relationships with major cerebrovascular and cardiovascular events and recurrent stroke. Also, they are suggested that PP has an important predictive power than other commonly used BP parameters<sup>20</sup>. For ischemic stroke event, other analysis based on the REGARDS population demonstrated that PP was an independent predictor of stroke event after adjusting for DBP or MAP, but not after adjusting for SBP<sup>21</sup>. A meta-analysis of 16 cohort clinical studies in Japan suggested that a substantial association between PP and ischemic stroke in men<sup>22</sup>. On the other hand, SBP and DBP were not compared with PP in this meta-analysis. Recently, Chang JJ et al. reported that PP as an independent predictor for in hospital mortality in patients with spontaneous intracerebral hemorrhage<sup>23</sup>.

Hypertension, age, hyperlipidemia and Diabetes Mellitus are major risk factors for atherosclerotic cerebrovascular disease<sup>24</sup>. In our study, hypertension was significantly more common in acute ischemic stroke patients. Age was significantly higher in acute ischemic stroke patients than in healthy controls. Stroke-related sympathetic activation is high in patients with acute ischemic stroke. Irrespective of prior cardiovascular status, an acute phase of stroke markedly influences LV function, and biochemical parameters (Glucose, troponin, creatinine)<sup>25</sup>. In this study, we found that LVEF was significantly lower in acute ischemic stroke patients than in healthy controls. Ozturk U et al. found that the severe acute ischemic stroke patients had lower LVEF<sup>26</sup>.

Hendrix P et al. found that diabetes mellitus history is an important predictor of stroke severity<sup>27</sup>. Lindsberg et al. suggested that increased blood glucose is frequent in the acute period of stroke<sup>28</sup>. In our study blood glucose and HbA1c levels were significantly higher in acute ischemic stroke patients than in healthy controls. Lindsberg PJ et al. reported that diabetes is frequent in severe acute ischemic patients. But, stress related hyperglycemia is more common in these patients<sup>28</sup>. In our study we found that E/e' value was significantly higher in severe stroke patients. Ryu WS et al. suggested that E/e' ratios were associated with arterial occlusion in AF-related stroke and may play a role in identifying patients at high risk of severe stroke<sup>29</sup>. In this study we found that creatinine levels were significantly higher in acute ischemic stroke patients. Mostofsky E et al. suggesting that, shared risk factors underlying vascular diseases including age, diabetes mellitus, hypertension, left ventricular hypertrophy may represent a unique vascular pathogenesis resulting from reduced renal clearance. Renal function predicts survival in patients with acute ischemic stroke<sup>30</sup>.

## CONCLUSION

This study demonstrated that PON1 activity is lower and PPI is higher in acute ischemic stroke patients than control subjects. Our results suggested that, PON-1 activity is an independent predictor of pulse pressure index in acute ischemic stroke patients. PON-1 weakly correlates with pulse pressure index.

**Ethics Committee Approval:** The study was accepted by the Ethics Committee of our hospital and informed consent was obtained from all patients. The study was performed in accordance with the principles of the Declaration of Helsinki. Ethics committee approval was obtained for this protocol 411 on 30 / 12 / 2013.

**Declaration of Conflicting Interests:** The authors declare that they have no conflict of interest.

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