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Evaluation of Carotid Intima-Media Thickness by Ultrasonography in Patients Presenting with Primary and Secondary Cardiovascular Disease

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Abstract

Background and Introduction: Carotid Intima-Media Thickness (CIMT) is an established non-invasive indicator for early detection of atherosclerosis. By using carotid artery hemodynamics and CIMT measurement to distinguish between primary and secondary cardiovascular disease (CVD), risk assessment and therapy may be improved.

Materials and Method: A total of 100 participants were enrolled, including 50 patients with primary CVD and 50 with secondary CVD. This cross-sectional study was conducted at Fatima Medical Complex, Rahim Yar Khan. Carotid IMT and blood flow velocities were measured bilaterally. Independent samples t-tests were used to compare the groups.

Results: A total of hundred patients were comprised, and a comparative analysis of the right and left intima-media thickness, velocities and ICA/CCA ratios were demonstrated. The participants' average age was 58.45 ± 12.37 years, and 70% of them were men. Patients with secondary CVD had considerably greater right and left carotid IMTs than those with primary CVD ($p < 0.001$). Patients with secondary CVD had significantly reduced blood flow velocities in both the left and right common carotid arteries ($p < 0.001$). Nevertheless, there were no statistically significant differences between the two groups according to the ICA/CCA ratios.

Conclusion: Significantly elevated carotid IMT and decreased carotid artery blood flow velocities are associated with secondary CVD, suggesting more advanced vascular pathology. While ICA/CCA ratios may not be very useful in distinguishing between different phases of the disease, carotid ultrasonography is a useful, non-invasive method for determining the severity of the condition.

Keywords: Atherosclerosis, Cardiovascular Disease (CVD), Carotid Intima-media thickness (CIMT), Primary CVD, Secondary CVD, Ultrasonography

Introduction

1.1 Background

Globally, cardiovascular diseases (CVDs) constitute the primary cause of morbidity and mortality. For prompt intervention and the avoidance of harmful cardiovascular events, early diagnosis of vascular alterations is essential. Ultrasonography measures carotid intima-media thickness

(CIMT), a non-invasive biomarker for arterial wall alterations and atherosclerosis. A higher CIMT is a useful indicator of cardiovascular risk since it has been connected to increased risks of myocardial infarction and stroke. A radiation-free and reasonably priced way to diagnose CIMT early is through ultrasonographic assessment, which enables preventive interventions like medication and lifestyle changes. With a focus on risk stratification and disease prevention, this study attempts to assess changes in CIMT in patients presenting primary and secondary cardiovascular diseases.

1.2 Introduction

Cardiovascular diseases are considered to be among the world's top causes of death and, if neglected, can have long-term effects. The most common types of cardiovascular disease (CVD) include coronary artery disease (CAD), peripheral arterial disease, cerebrovascular illness, and congenital heart disease. (Ho, 2018). The most prevalent kind of CVD, coronary artery disease is characterized by narrowing of the circulatory channels that provide oxygen-rich blood to the heart. This happens because plaque, which is a mixture of calcium, fibrous connective tissue, macrophage cells, and cholesterol, is deposited inside coronary arteries (Shao et al., 2020). Atherosclerosis is the name given to this condition. When these plaques burst, blood clots form inside the arteries, which may cause the heart muscles' blood supply to be partially or totally blocked (Libby, 2021).

Angina pectoris, myocardial infarction, and dyspnea (shortness of breath) are signs of coronary artery disease (CAD). A condition known as angina occurs when the myocardium's blood flow is severely diminished, causing the sternum to feel constricted or scorching. But at this point, myocardial necrosis has not yet materialized (Kaski & Kaski, 2016). However, myocardial infarction, also known as a heart attack, is a condition where the absence of oxygenated blood causes myocardial cells to die (Reed, Rossi, & Cannon, 2017). In addition, there is a substantial correlation between CAD and diabetes mellitus, also known as diabetes. According to studies, hyperglycemia causes metabolic alterations in the human body that hasten the development of atherosclerosis. Research has shown that blood pressure and cholesterol had the greatest contributions to CAD among those factors. Low density lipoprotein (LDL) cholesterol raises the risk of coronary artery disease (CAD) more than HDL cholesterol does. It has been discovered that stage 1 hypertension increases the risk of coronary artery disease (CAD) (Jousilahti et al., 1999).

Increased intima media thickness of common carotid artery readings have the potential to increase ischemic stroke, including intracerebral hemorrhage events and the left ventricular dysfunction subtype. Measurements of carotid intima thickness have been linked to the risk of stroke and its subtypes, and they may be utilized as a diagnostic indicator to forecast the likelihood of stroke episodes (Owolabi, Akpa, & Agunloye, 2016). Carotid atherosclerosis is one of the primary and preventable causes of ischemic stroke. It starts early in childhood and develops gradually over time without being noticed. To start early, active vascular prophylaxis, people with subclinical atherosclerosis must be identified. Although carotid plaque appears to be a powerful predictor of cardiovascular risk, carotid intima-media thickness (CIMT) and arterial stiffness are important novel biomarkers of carotid atherosclerosis because they can be identified in the early stages (Fernández-Alvarez et al., 2022).

Traditional cardiovascular risk variables like age, sex, and race are mostly linked to CIMT. Increases in CIMT include smoking, drinking alcohol, not exercising, hypertension, dyslipidemia, bad eating habits, medication therapy, glycaemia, and obesity-related illnesses. Not all of the risk for CHD can be explained by conventional risk factors. According to reports, established cardiovascular risk factors and demographics did not account for over 60% of CHD cases. This may be caused by novel risk factors such heredity, the presence of particular genotypes,

immunological diseases, inflammatory cytokines, and haematological parametersn(Strawbridge et al., 2020).
The aim of this study is to evaluate the carotid intima-media thickness in patients presenting with primary or secondary cardiovascular disease. Ultrasound measurement of carotid intima-media thickness is an accurate way to evaluate subclinical atherosclerosis and provides important information about cardiovascular risk. A higher CIMT is interlinked with a higher risk of subsequent cardiac events in patients with primary or secondary cardiovascular disease. Because of this, it is a helpful tool for risk assessment, early detection, and tracking the course of a disease or its response to treatment. Personalized cardiovascular care and preventive measures are supported by the inclusion of CIMT examination.

Research Methodology

This cross-sectional study was conducted over three months at Fatima Medical Complex, Rahim Yar Khan, following approval of the synopsis. A sample of 100 patients, reduced from the initially calculated 128 due to time constraints, was divided into groups with primary and secondary cardiovascular disease (CVD). Participants aged 18 and above with CVD risk factors or history of cardiovascular events were included, while those with prior carotid interventions, anatomical limitations, or other exclusions were omitted. High-resolution B-mode ultrasonography using a LOGIC P5 machine and a 7.5–12 MHz convex probe was employed to measure carotid intima-media thickness (CIMT). Scans were conducted in the supine position, with measurements taken from both sides of the distal common carotid artery. An average of three measurements per side was used for analysis. Data were recorded using a structured sheet and analyzed with SPSS. Quantitative data were expressed as means and standard deviations; qualitative data were presented as frequencies and percentages. Independent T-tests determined statistical significance, with a p-value ≤ 0.05 considered significant. Ethical standards were maintained by obtaining informed consent, ensuring participant confidentiality, and allowing voluntary withdrawal without consequence.

Results

The resolution of this cross-sectional observational study's objective was to evaluate carotid intima-media thickness in patients presenting with primary and secondary cardiovascular diseases by the use of ultrasonography. The investigation was conducted at the Radiology Department of Fatima Medical Complex, Rahim Yar Khan Pakistan. By analyzing the IMT thickness of left and right carotid artery, the research seeks to identify potential increase of CIMT in response to the buildup of plaque and thickening of the arterial wall, which may serve as an early indicators of primary CVD. Starting from the time the study's description was approved, the investigation lasted for three months.
To choose the study participants, a convenient sampling technique was used. The inclusion criteria consisted of patients **with primary risk factors such as hypertension, diabetes mellitus, dyslipidemia, and obesity, smoking or family history of CVD**. Patients with documented history of cardiovascular events like myocardial infarction, stroke, angina or revascularization procedures. Ones suitable for carotid ultrasonography and able to undergo the procedure, willing to give informed consent and adults aged **≥ 18 years.** Exclusion criteria comprised patients with previous carotid artery intervention or surgery, pregnant women and patients with severe mental illness or cognitive impairment.
In all one hundred individuals were included in the study. Ultrasonography machine of LOGIC P5 was used with a convex probe to identify the intima-media thickness of carotid artery. Radiologists

then examined that there was a difference in CIMT of primary and secondary CVD patients as the CIMT of patients with secondary CVD is greater than the CIMT of patients with primary CVD.

4.1 Tables

Table 4.2.1 : Frequency distribution of gender

	Frequency	Percent
Female	30	30.0
Male	70	70.0
Total	100	100.0

The frequency distribution of gender is displayed in Table 4.2.1. Out of 100 participants, 70 participants are male while 30 participants are female.

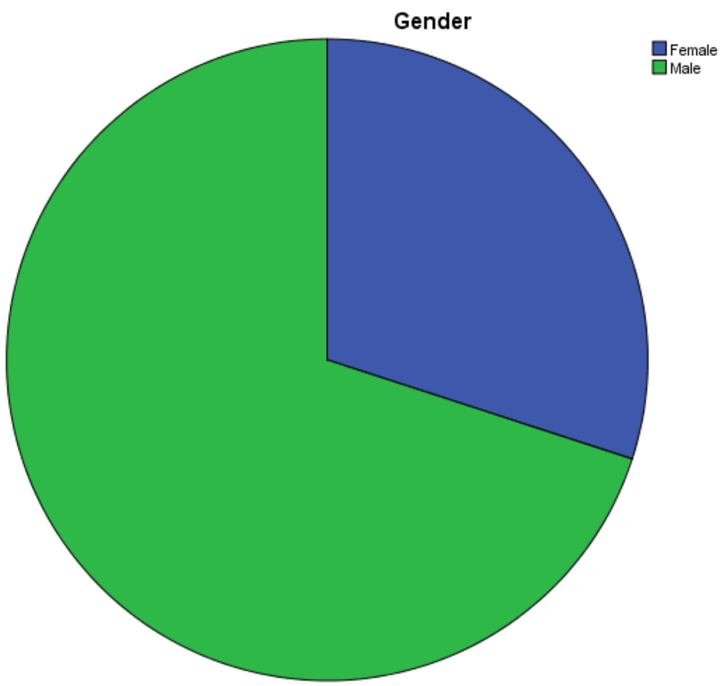

Figure 4.2.1: Pie chart of gender frequency distribution

Table 4.2.2: Descriptive statistics of age

Descriptive Statistics					
	N	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**
Age	100	35	85	58.45	12.366

The age distribution of 100 participants is summarized in the table 4.2.2. With a mean age of 58.45 years and a standard deviation of 12.366, the participants' ages varied from 35 to 85 years, suggesting moderate age variability. Every one of the 100 entries was legitimate and incorporated into the analysis.

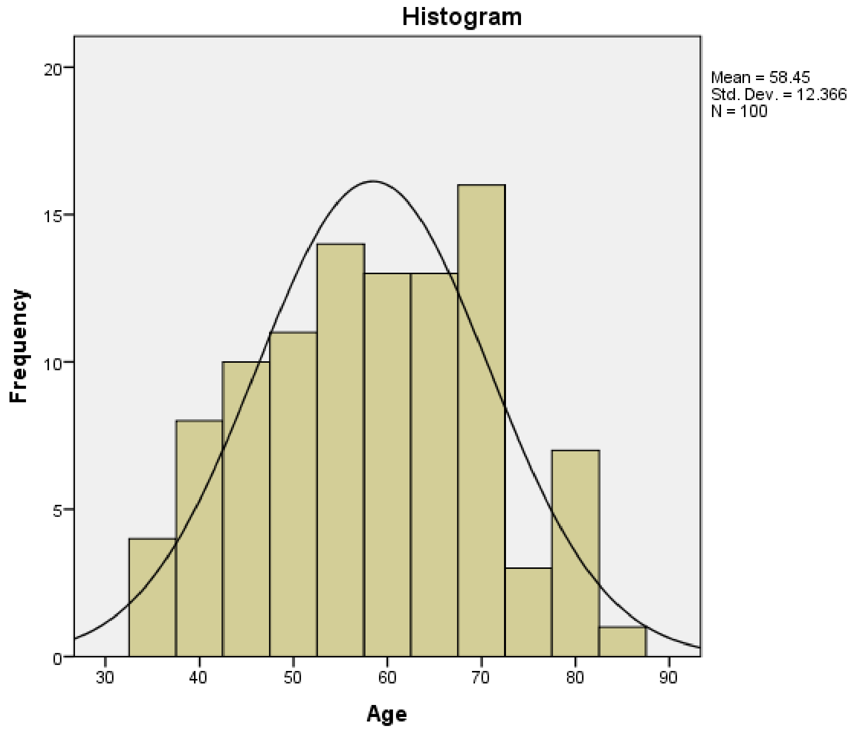

Figure 4.2.2: Histogram of age frequency distribution

Figure 4.2.2 shows the age frequency distribution of a sample of 100 people using a histogram. It displays an exceptionally normal distribution, with the majority of participants being between the ages of 50 and 70. With a mean age of 58.45 years and a standard deviation of 12.37, the age distribution exhibits substantial variability. There are fewer elderly individuals in the sample. In general the histogram shows that the majority of the population being studied is middle-aged to older.

Table 4.2.3: Group statistics of Right Intima-media thickness

Group Statistics					
	CVD	**N**	**Mean**	**Std. Deviation**	**Std. Error Mean**
R IMT (mm)	**Primary CVD**	50	0.770	.1233	.0174
	Secondary CVD	50	1.738	.3446	.0487

Table 4.2.2 shows group statistics of intima-media thickness of the right carotid artery. The mean of 50 patients with primary CVD is 0.770 while the mean of 50 patients with secondary CVD is 1.738. The standard deviation of RIMT of 50 primary CVD patients is 0.1233. On the other hand, the standard deviation of RIMT of patients with secondary CVD is 0.3446.

Table 4.2.4: Independent t-test of Right IMT

Independent Samples Test		
	Levene's Test for Equality of Variances	**t-test for Equality of Means**

		F	Sig.	t	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
R IMT (mm)	**Equal variances assumed**	29.726	.000	-22.567	98	.000	-1.1680	.0518	-1.2707	-1.0653
	Equal variances not assumed			-22.567	61.347	.000	-1.1680	.0518	-1.2715	-1.0645

Table 4.2.3 presents the results of an independent t-test comparing Right Intima Media Thickness between two groups. Levene's test for equality of variances showed a significant result (F =29.726, p = 0.000), indicating unequal variances between the groups. The t-test reveals a significant difference in Right IMT between the groups (t = -22.567, df ≈ 61.347, p < 0.000), with a mean difference of -2.640. The 95% confidence interval for the difference ranges from -1.2715 to -1.0645, confirming that the difference is statistically significant and not due to random chance.

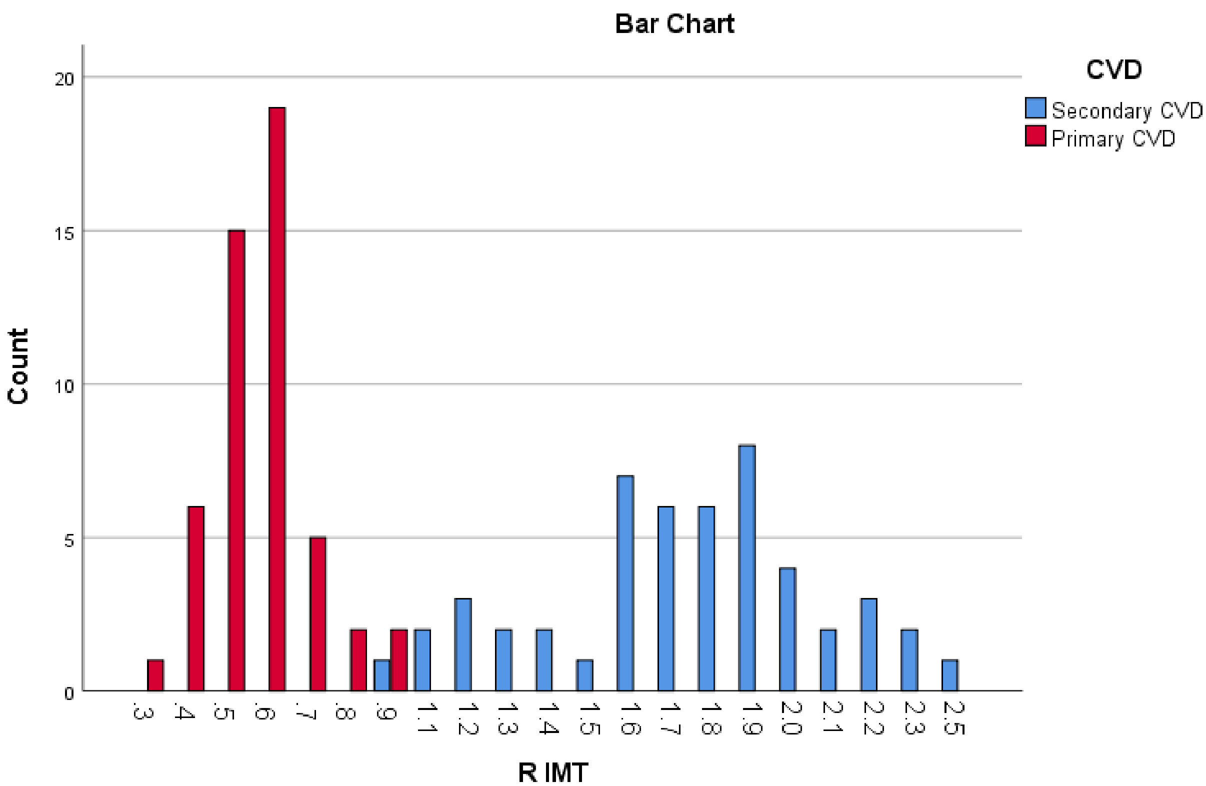

Figure 4.2.6 Graph showing cross tabulation between RIMT in Primary and Secondary CVD patients

The right intima-media thickness (RIMT) of patients with primary and secondary CVD is compared in the bar chart. It indicates a potential progression in arterial thickening by showing that patients with Primary CVD are more likely to have lower RIMT values (0.3–0.8 mm), while patients with Secondary CVD are more likely to have greater RIMT values (1.3–2.5 mm).

Table 5.2.4: Group statistics of Left Intima-media thickness

Group Statistics					
	CVD	N	Mean	Std. Deviation	Std. Error Mean
L IMT (mm)	Primary CVD	50	0.856	0.1656	0.0234
	Secondary CVD	50	1.656	0.3137	0.0444

Table 4.2.4 shows group statistics of intima-media thickness of the left carotid artery. The mean of 50 patients with primary CVD is 0.856 while the mean of 50 patients with secondary CVD is 1.656. The standard deviation of LIMT of 50 primary CVD patients is 0.1656 while the standard deviation of LIMT of patients with secondary CVD is 0.3137.

Table 4.2.6: Independent t-test of Left IMT

Independent Samples Test										
		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference: Lower	Upper
L IMT (mm)	Equal variances assumed	24.568	.000	-19.933	98	.000	-1.0000	.0502	-1.0996	-.9004
	Equal variances not assumed			-19.933	74.327	.000	-1.0000	.0502	-1.1000	-.9000

The Left Intima Media Thickness (L IMT) results of an independent samples t-test are shown in the table. The assumption of equal variances is violated according to Levene's Test for Equality of Variances, which is significant (F = 24.568, p = 0.000). There is a statistically significant difference in Left IMT between the two groups, as indicated by the highly significant t-test result (t = -19.933, df ≈ 74.327, p < 0.000). With a 95% confidence interval ranging from -1.1000 to -0.9000 and a mean difference of -1.0000 with a standard error of 0.502, it appears that the true mean difference is negative and excludes zero.

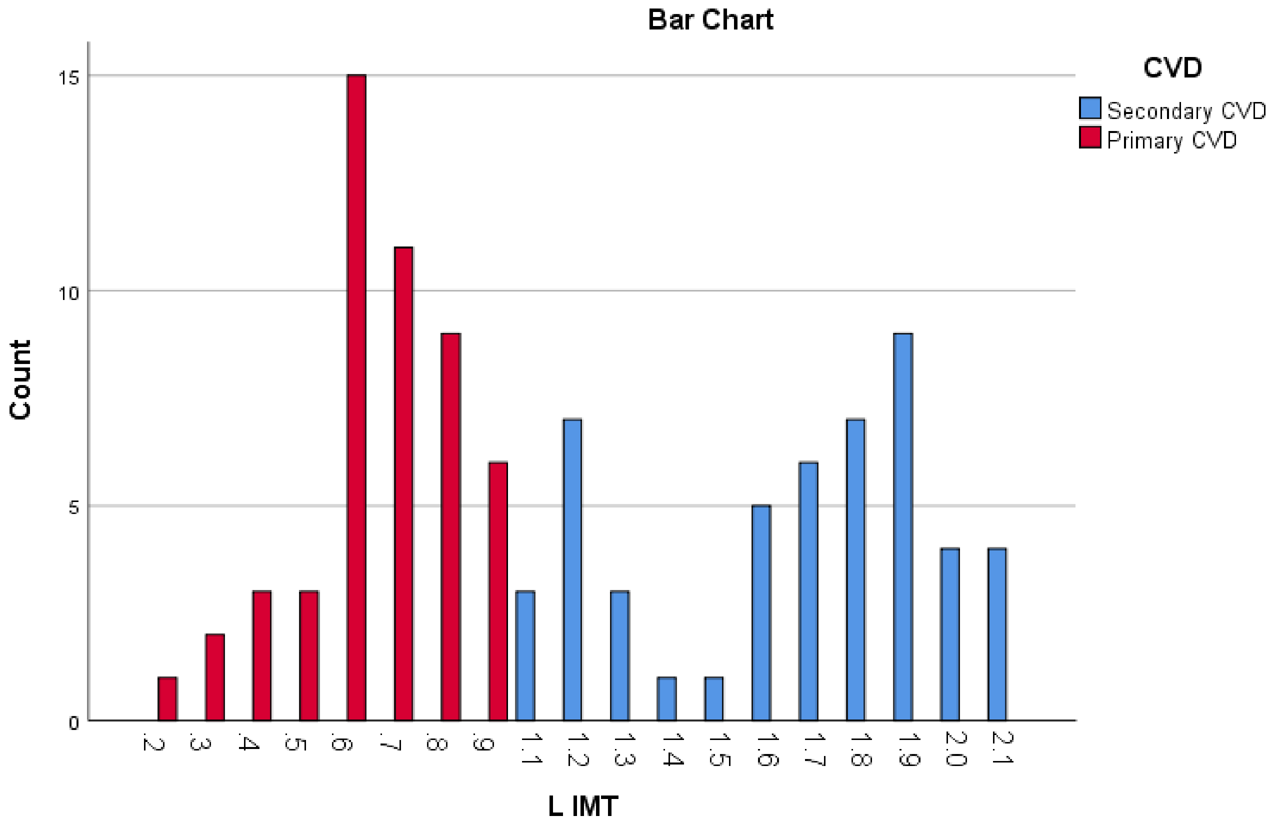

Figure 4.2.3 Graph showing cross tabulation between RIMT in Primary and Secondary CVD patients

The distribution of L IMT (Left Intima-Media Thickness) in patients with primary and secondary CVD is shown in the bar chart. While secondary CVD patients predominate in the higher L IMT range (1.1–2.1 mm), indicating increasing arterial thickening in more advanced instances, primary CVD patients exhibit higher frequency at lower L IMT values (0.2–0.9 mm).

Table 4.2.7: Group statistics of Right CCA Velocity

Group Statistics					
	CVD	**N**	**Mean**	**Std. Deviation**	**Std. Error Mean**
R CCA Velocity	**Primary CVD**	50	64.7800	14.49882	2.05044
	Secondary CVD	50	47.9600	18.13212	2.56427

Table 4.2.6 shows group statistics of the velocity of right common carotid artery. The mean of 50 patients with primary CVD is 64.78 and the mean of the 50 patients with secondary CVD is 47.96. The standard deviation of primary CVD is 14.49882 while the standard deviation of secondary CVD is 18.13212.

Table 4.2.8: Independent t-test for Right CCA Velocity

Independent Samples Test		
	Levene's Test for Equality of Variances	**t-test for Equality of Means**

		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
R CCA Velocity	Equal variances assumed	5.410	.022	-5.123	98	.000	-16.82000	3.28326	-23.33552	-10.30448
	Equal variances not assumed			-5.123	93.477	.000	-16.82000	3.28326	-23.33946	-10.30054

Table 4.2.7 shows the results of an independent t-test comparing right CCA Velocity between two groups. Levene's test for equality of variances showed a significant result ($F = 5.410$, $p = 0.022$), indicating unequal variances between the groups. The t-test reveals a significant difference in right CCA velocity between the groups ($t = -5.123$, $df \approx 93.477$, $p < 0.022$), with a mean difference of -16.82. The 95% confidence interval for the difference ranges from -23.33946 to -10.30054, confirming that the difference is statistically significant and not due to random chance.

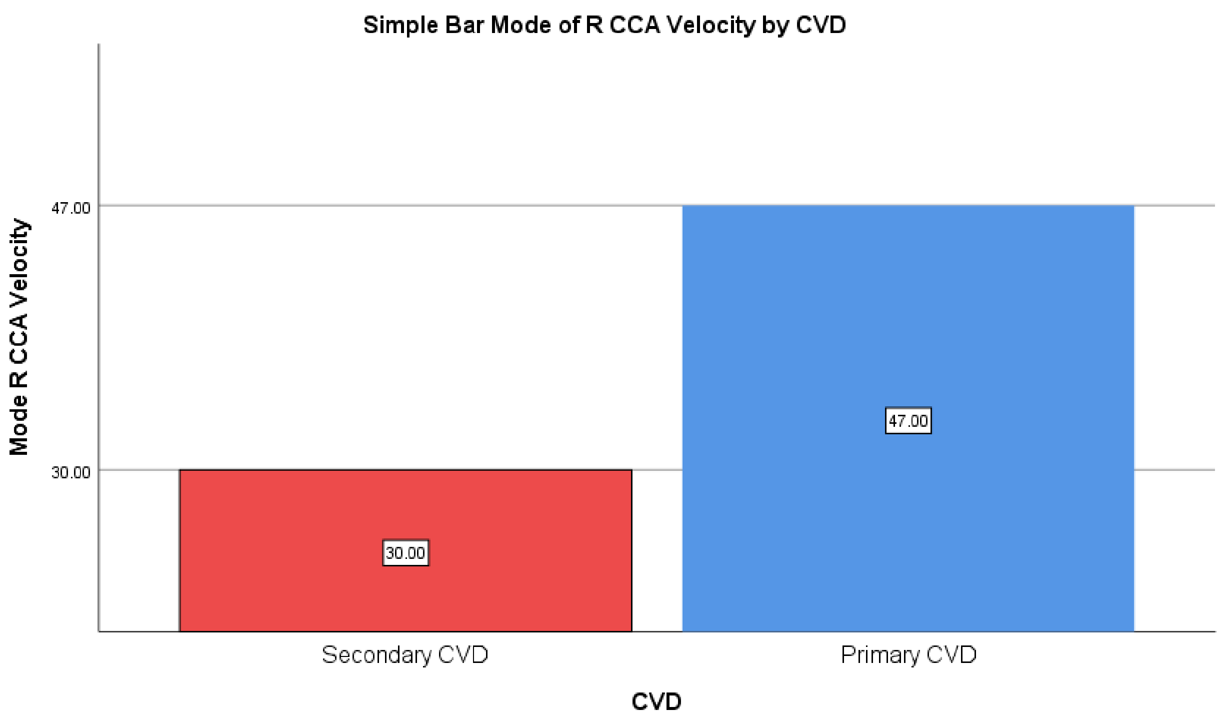

Figure 4.2.4 Simple bar mode of RCCA by CVD

The Right Common Carotid Artery (RCCA) velocity mode in individuals with primary and secondary CVD is illustrated in this bar chart. It demonstrates that primary CVD patients had a greater RCCA velocity, 47 cm/s than secondary CVD patients with 30 cm/s. This implies more decrease in blood flow velocities in secondary CVD patients which attributed to atherosclerotic burden and arterial stiffness.

Table 4.2.9: Group statistics of Left CCA Velocity

Group Statistics					
	CVD	N	Mean	Std. Deviation	Std. Error Mean
L CCA Velocity	Primary CVD	50	65.04	12.935	1.829
	Secondary CVD	50	52.46	17.738	2.508

Table 4.2.8 shows group statistics of the velocity of left common carotid artery. The mean of 50 patients with primary CVD is 65.04 and the mean of the 50 patients with secondary CVD is 52.46. The standard deviation of primary CVD is 12.935 while the standard deviation of secondary CVD is 17.738.

Table 4.2.10: Independent t-test for L CCA Velocity

Independent Samples Test										
		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
L CCA Velocity	Equal variances assumed	3.771	.055	-4.052	98	.000	-12.580	3.105	-18.741	-6.419
	Equal variances not assumed			-4.052	89.625	.000	-12.580	3.105	-18.748	-6.412

Table 4.2.9 shows the results of an independent t-test comparing left CCA Velocity between two groups. Levene's test for equality of variances showed a significant result (F = 3.771, p = 0.055), indicating unequal variances between the groups. The t-test result is statistically significant (t = -4.052, df = 98, p < 0.001), indicating a significant difference in L CCA velocity between the two groups. The mean difference is -12.580 with a standard error of 3.105, and the 95% confidence interval for the difference ranges from -18.741 to -6.419. This implies that the difference is both statistically and practically significant, with the group means differing by a substantial margin.

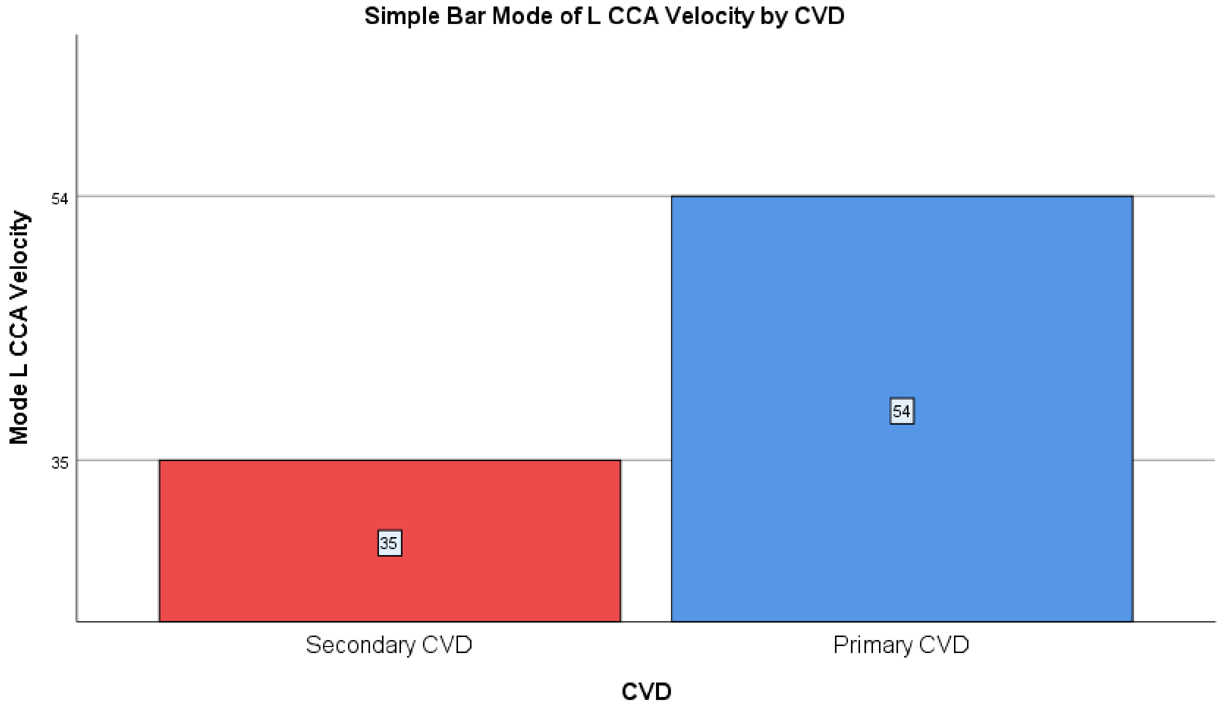

Figure 4.2.5 Simple bar mode of RCCA by CVD

Simple bar mode of L CCA Velocity by primary and secondary CVD. This graph shows that the peak systolic velocity of secondary CVD (35 cm/s) is lower than the peak systolic velocity of primary CVD (54 cm/s).

Table 4.2.11: Group statistics of R ICA/CCA Ratio and L ICA/CCA Ratio

Group Statistics					
	CVD	**N**	**Mean**	**Std. Deviation**	**Std. Error Mean**
R ICA/ CCA Ratio	**Secondary CVD**	50	.98	.070	.010
	Primary CVD	50	.96	.095	.013
L ICA/CCA Ratio	**Secondary CVD**	50	.95	.089	.013
	Primary CVD	50	.96	.095	.013

The Internal Carotid Artery/Common Carotid Artery ratios for the right and left sides of patients with primary and secondary cardiovascular disease (CVD) are compared in the table using group data. Secondary CVD patients had a slightly higher mean value (0.98 ± 0.070) for the right ICA/CCA ratio than the primary CVD patients (0.96 ± 0.095). On the other hand, the mean for secondary CVD patients' left ICA/CCA ratio is 0.95 ± 0.089, which is slightly lower than the mean for primary CVD patients, which is 0.96 ± 0.095. Overall, there aren't many differences across the groups, and standard errors indicate that the variability is comparable.

Table 4.2.12: Independent Samples t-test results comparing the Right and Left ICA/CCA ratios between primary CVD and secondary CVD

Independent Samples Test										
		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
R ICA/ CCA ratio	**Equal variances assumed**	10.433	.002	1.403	98	.164	.023	.017	-.010	.056
	Equal variances not assumed			1.403	89.836	.164	.023	.017	-.010	.057
L ICA/CCA Ratio	**Equal variances assumed**	.414	.521	-.108	98	.914	-.002	.018	-.039	.035
	Equal variances not assumed			-.108	97.633	.914	-.002	.018	-.039	.035

This table presents the Independent Samples t-test results comparing the Right and Left ICA/CCA ratios between primary CVD and secondary CVD. Levene's Test for Equality of Variances of Right ICA/CCA Ratio showed F = 10.433, p = 0.002, which is significant, indicating unequal variances. The t-test Results show t = 1.403, df = 89.836, p = 0.164 (not significant) with mean difference = 0.023. The 95% confidence interval is between -0.010 to 0.057. There is no statistically significant difference in the right ICA/CCA ratio between the two groups, despite the difference in variances. Levene's Test showed F = 0.414, p = 0.521 (not significant), so we assume equal variances. The t-test results showed t = -0.108, df = 98, p = 0.914 (not significant). The mean difference is -0.002 with 95% confidence interval is between -0.039 to 0.035.There is no statistically significant difference in the left ICA/CCA ratio between the groups. The p-value is very high, and the confidence interval spans zero. Neither the right nor left ICA/CCA ratios exhibited statistically significant differences between the groups, suggesting that this ratio may not be a distinguishing feature in this sample between Primary and Secondary CVD.

Discussion

The objective of this study was to use ultrasonography to assess carotid intima-media thickness (IMT) and related hemodynamic parameters in individuals with primary and secondary cardiovascular disease (CVD). It was suggested that a method called B-mode high-resolution ultrasound offers one of the most effective techniques for identifying atherosclerosis in its early stages (Fedak, Ciuk, & Urbanik, 2020). In comparison our study emphasize the non-invasive nature of ultrasonography. CIMT change over time is thought to be an effective way to track atherosclerosis's natural course and evaluate the average response to treatment (Bots et al., 2016). Relative to our study, both statements focus on CIMT as a key parameter in evaluating cardiovascular health.

In this study it was suggested that the intima-media thickness of carotid artery was increased in primary and secondary CVD. IMT and incident CVD have been found to be strongly correlated in numerous major epidemiological studies; nevertheless, there is insufficient evidence to support the use of CIMT in clinical practice (Ravani et al., 2015). For instance, a systematic review and meta-analysis reported that each 0.10 mm increase in common carotid artery IMT is associated with a 15% higher risk of myocardial infarction and an 18% higher risk of stroke (Lorenz et al., 2007).

The findings of this study supported the hypothesis that secondary CVD is linked to more vascular changes by showing significant differences in IMT and carotid artery blood flow velocities between the two patient groups. The Multi-Ethnic Study of Atherosclerosis (MESA) found that higher IMT scores, reflecting increased arterial thickness, are linked to a greater risk of coronary heart disease (Orimoloye et al., 2019). Individuals with secondary CVD had considerably higher readings of the right and left carotid IMT than individuals with primary CVD. Large mean differences and statistical significance ($p < 0.000$) imply that carotid IMT could be a useful surrogate marker for the progression of the disease (Bots, 2006). The risk variables that are independently linked to prevalent CVD have slightly varied associations with CCA and ICA IMT (Polak et al., 2010). These results are in consistent with previous studies showing that recurrent cardiovascular events and atherosclerotic load, both increase IMT (Den Ruijter et al., 2012).

The age distribution of the participants (mean age ~58.5 years) and male preponderance (70%) are characteristic of CVD patients, particularly in countries that are developing (Kolonko et al., 2022). Future vascular events are independently predicted by carotid IMT. In younger individuals, its predictive value is at least as strong as in older people (Lorenz et al., 2006). The most significant factors were age and gender, which accounted for 23.5% of the variability of the CCA IMT and 22.5% of the ICA IMT, respectively. Systolic blood pressure (1.9%) and smoking (1.6%) were the next most significant factors. Both the CCA and ICA IMT were statistically significant predictors of prevalent CVD (Polak et al., 2010).

Our results of lower left and right CCA velocities in patients with secondary CVD are consistent with research that indicates these patients have progressed vascular remodeling. For instance, (Stein et al., 2015) found that patients with recurrent cardiovascular events had comparable decreases in carotid blood flow velocities, which they attributed to atherosclerotic burden and arterial stiffness. In a Pakistani cohort study, (Khan et al., 2020) also found that secondary CVD patients had lower velocities. They related this to higher plaque burden and artery narrowing, which supports our significant mean differences of -16.82 (right CCA) and -12.58 (left CCA). As we discovered in both the right and left CCA, there are notable variations in blood flow velocities between the primary and secondary CVD groups. These findings are consistent with those of (Nakamura & Muraoka, 2018), who also noted a higher decrease in CCA velocities in patients with secondary CVD. Their research, which concentrated on individuals with a history of myocardial infarction or stroke, revealed that recurring episodes deteriorate vascular health and cause blood flow velocities to further drop.

The ICA/CCA ratios between the primary and secondary CVD groups in our study did not alter significantly, suggesting compensatory mechanisms that keep this ratio constant as the disease progresses. This is consistent with the recognition that the ICA/CCA ratio stays constant because of adaptive responses in the arterial system, even if IMT and blood flow velocities are sensitive indicators of vascular alterations (Saba et al., 2022).

Conclusion

The study reveals notable differences between patients with primary and secondary CVD in terms of carotid artery blood flow velocities and carotid intima-media thickness, with secondary CVD associated with reduced flow velocities and thicker intima-media layers. These results highlight the effectiveness of carotid ultrasonography as a non-invasive, informative tool for assessing the degree and severity of cardiovascular disease. ICA/CCA ratios, however, did not differ significantly, indicating that this parameter alone has limited diagnostic use in differentiating disease stages. To validate these results and improve the implementation of carotid characteristics in clinical risk classification, larger, more diverse populations are required for future research.

Recommendations

In order to track the evolution of cardiovascular disease, it is recommended that patients who are at risk of developing it or who already have it undergo routine evaluations that include carotid IMT measurement and blood flow velocity assessment. Early carotid screening should be considered for middle-aged and older persons, particularly those with cardiovascular risk factors, in order to detect subclinical atherosclerosis and start prompt therapies. Medical professionals should give IMT and flow velocity measurements preference over ratio evaluations when distinguishing between disease stages because the ICA/CCA ratio did not reveal any noticeable difference between primary and secondary CVD. To better understand the predictive value of carotid IMT and velocity variations over time in cardiovascular outcomes, future research should concentrate on larger, multi-center, longitudinal investigations. To stop the development of subsequent cardiovascular events, patients with elevated IMT or decreased carotid velocity should be the focus of rigorous lifestyle and medication therapy.

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