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MYOCARDIAL BRIDGE TYPE AND PROXIMAL STENOSIS RELATIONSHIPS IN HYPERTENSIVE PATIENTS

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ABSTRACT

This study aimed to study the predisposing factors of hypertension as well as the relationships between myocardial bridge type and proximal stenosis in hypertensive patients.

A total of 200 MB patients at El-Azhar Hospital were selected for this quantitative study. Among them 80 patients with normal blood pressure (BP) and stenosis were excluded. Most of the patients had come to the hospital with complaints for chest tightness/pain and underwent MDCT scan due to suspicions of coronary artery disease and they were diagnosed with MB. Among remaining 120 patients, 7 5 were (62.5%) males and 55 were (45.83%) females, with the average age of patients at 68.02 ± 12.65.

Data of each individual patient's age, sex, BP, blood cholesterol level, diabetes status, bridge length, bridge type, artery involved, and stenosis were all recorded. Patients consent was taken prior to the MDCT scan andoral consent from the ethical committee was taken to carry out this research.

This study concluded that, the main predisposing risk factors for hypertension includes , male is more susceptable than female, hypercholesterol, diabetes, smoking. Also, there was strong evidence of atherosclerosisin the proximal part of the artery, while the bridged andtherefore tunneled artery showed no atherosclerosis. Theresults of this research, therefore, indicate that there isno significant relationship between the MB and stenosisin hypertensive patients.

Kew wards:

Myocardial bridge - Proximal stenosis -Hypertensive patients

INTRODUCTION

Systemic arterial hypertension (hereafter referred to as hypertension) is characterized by persistently high blood pressure (BP) in the systemic arteries. BP is commonly expressed as the ratio of the systolic BP (that is, the pressure that the blood exerts on the arterial walls when the heart contracts) and the diastolic BP (the pressure when the heart relaxes). **(Oparil et al., 2018).**

The BP thresholds that define hypertension depend on the measurement method. Several aetiologies can underlie hypertension. The majority (90–95%) of patients have a highly heterogeneous 'essential' or primary hypertension with a multifactorial gene-environment aetiology. A positive family history is a frequent occurrence in patients with hypertension, with the heritability (a measure of how much of the variation in a trait is due to variation in genetic factors) estimated between 35% and 50% in the majority of studies **(Fagard et al., 1995 and Luft , 2001).**

Hypertension is the most common preventable risk factor for cardiovascular disease (CVD; including coronary heart disease, heart failure, stroke, myocardial infarction, atrial fibrillation and peripheral artery disease), chronic kidney disease (CKD) and cognitive impairment, and is the leading single contributor to all-cause death and disability worldwide **(Forouzanfar et al., 2015).**

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The relationship between BP and the increased risk of CVD is graded and continuous, starting as low as 115/75 mmHg, well within what is considered to be the normotensive range. Successful prevention and treatment of hypertension are key in reducing disease burden and promoting longevity in the world's population. In treating hyperteinsion, it is important to consider a person's predicted atherosclerotic CVD (ASCVD) risk more than the level of BP alone, as persons with high CVD risk derive the greatest benefit from BP lowering treatment **(Oparil et al., 2018)..**

Proximal RCA is defined as the ostium to one-half the distance to the acute margin of the heart, the LM as the ostium to the bifurcation of the LAD artery and CX, the proximal LAD artery from the end of the LM to the first diagonal, and the proximal CX as the end of LM to the origin of the obtuse marginal. For stenosis grading, all studies used a cut-off value of ≥ 50% DS to determine the presence of obstructive CAD. Three out of four studies also reported an additional cut-off value of ≥ 70% DS **(Andreini et al., 2014; Hamdan et al., 2015 and Rossi et al., 2017).**

The myocardial bridge (MB) is an anatomical variant in which part of the coronary artery runs under the myocardium**. (Moehlenkamp et al., 202).** MB was first seen by Reyman during an autopsy in **1737 (Reyman)** and in 1960 it was angiographically observed for the first time by **(Portmann W, Iwig, 1960).** It is also called tunnel artery. **(Alegria et al., 2006)·** It mostly occurs in the left anterior descending (LAD) artery. The affected artery mayhave two bridges. In MB depth and length varies from 1-4 mm to 4-40 mm, respectively. The detection rate of MBis higher in multidetector computed tomography (MDCT) than coronary angiography (CAG). The detection rate of MB in autopsy is between 57% and 80%.

MB can be divided into following two types: Superficial and deep. In a superficial bridge, the artery is covered by the membranous myocardium, while in deep bridges the artery is in muscular myocardium showing a ''U'' shape.

During the systolic phase, the artery beneath the bridge is compressed by the surrounding myocardium, leading to transient stenosis in the artery seen particularly in deep bridges, which relaxes during the diastolic phase and causes a ''milking'' effect in the artery. The stenosis of the artery during the systolic phase is present to lesserextent in the superficial bridge. **(Juilliere et al., 1995).**

The predominant ethnicity presenting MBs is unknown, and high blood pressure is one of the significant factorsin the formation of atherosclerosis.

So, this study aimed to study the predisposing factors of hypertension as well as the relationships between myocardial bridge type and proximal stenosis in hypertensive patients

MATERIALS AND METHODS

Study population

A total of 200 MB patients at El-Azhar Hospital were selected for this quantitative study. Among them 80 patients with normal blood pressure (BP) and stenosis were excluded. Most of the patients had come to the hospital with complaints for chest tightness/pain and underwent MDCT scan due to suspicions of coronary artery disease and they were diagnosed with MB. Among remaining 120 patients, 7 5 were (62.5%) males and 55 were (45.83%) females, with the average age of patients at 68.02 ± 12.65.

Data of each individual patient's age, sex, BP, blood cholesterol level, diabetes status, bridge length, bridge type, artery involved, and stenosis were all recorded. Patients consent was taken prior to the MDCT scan andoral consent from the ethical committee was taken to carry out this research.

Procedure for the computed tomography examination/imageprocessing and analysis

Coronary angiographies were done using a Siemens CTsomatom definition dual-source scanner. The image was taken from the bifurcation of the trachea through to the end of diaphragm. Contrast iopadimal was used for the scan (100 mL) and 35-50 mL of normal saline was flushed through after the contrast was infused. Two radiologists visualized the images to evaluate the coronary arteries. Multiple planar reconstruction (MPR) and curved planar reconstruction (CPR) were mostly used so as to accurately diagnose of the type, length, depth, and location of the atherosclerosis.

Diabetes, cholesterol and smoking

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If the fasting plasma blood sugar was ≥7.0 or random plasma blood sugar was more than 11.1 mmol/L, the patient was said to be diabetic. If total blood cholesterol was more than 5.5 mmol/L, hypercholestolemia was identified. In regards to smoking, occasional smoking was not considered significant to this study, but a dailysmoking habit was considered positive.

Detection of MB

The detection of MB was based on the coronary artery being covered by membranous and muscular myocardium. The length of the bridge was calculated from the point where the coronary artery covered bythe membranous or muscular myocardium began and until the covering stopped. The depth of the bridge was calculated only in cases of deep bridge, as the artery becomes embedded in muscular myocardium and this covering can be calculated by measuring the thickness of the myocardium covering the artery. In superficial bridges, the covering is very thin and therefore cannot be calculated.

Detection of stenosis

By using MPR and CPR, the affected artery in the MB was visualized and then the artery's stenosis calculated.The classification of the stenosis was based on the American Heart Association's standards, called Nobile classification. The stenosis was divided into three grades 1. <50% stenosis 2. 50%-75% stenosis 3. >75%stenosis. This study is focused on the stenosis in the artery proximal to the bridge.

Category of blood pressure

Patients' BP was divided into four categories in accordance with the American Heart Association's standards

- Group N (normal) 90/60-119/79, (2) Group *P* (prehypertension) 120/80-140/90, (3) Group 1 (stage 1) 140/90-160/100, and (4) Group 2 (stage 2) ≥160/100 mm Hg. Patients with normal and prehypertension were excluded from the study while patients whose blood pressure falls in stage 1 and stage 2 were accepted (hypertensive) for this research.

Statistical analysis

Statistical analysis was done using SSPS software 11.0. If *P* value of less than 0.05 was considered statistically significant [Table 1].

RESULTS

Demographic characters of the patients:

Our results observed in Table (1) cleared that, the age of the patients in stage 2 their age higher than the age of patientsin stage 1 as their age was 7065 year in stage 2 whil, in stage 1 reached to 65.39 year.

The male to female ration in patients in stage 1 higher than that of the stage 2

The hypercholesterol level in stage 1 higher than that of the stage 1 as it observed in 15 (25 %) of the patient in stage 1 , while, in patient in stage 2 observed in the 10 (16.67 %) of the patient in stage 2.

The diabetes incidences in patient in stage-2 higher than that of the patient in stage-1 as it reached to 20 (33.33 %) in stage 2 and 15 (25 %) in patient in stage-1.

The smoker in patient of stage-1 higher than that of the patient in stage-2 as their number in stage-1 were 15 (25 %) and 13 (21.67 %0 in stage-2.

The incidence of hypertension in the stage-1 was 49 % and in stage 2 their incidence was 53 %.

MB

Superficial bridge

Among the 120 patients, superficial bridges were the most common type of bridge (67 patients or 55.83% of those studied) [Figure 1]. The mean average length of the bridge was 10.26 mm and among these patients,60 (89.56%) of superficial bridges were in the LAD artery.The most common location of the bridge in the LAD wasin the middle segment (> 80%) of the artery, while the second most common location was the proximal part of the artery. Among these 67 superficial bridges, 3 (4.48%)were located in RCA and 2 (2.98%) in the diagonal arteries.

Deep bridge

There were 46 (38.34%) patients (out of 120) suffering frommyocardial deep bridge [Figure 2], and the mean lengthand depth of these bridges were 7.14 and 4.29 mm, respectively. More than 90% of the bridge was found in the middle segment, while the remainder was in the proximal segment, of 38 deep bridge patients, 34 (89.4%)patients had bridges in the LAD artery, 1 (3%) patient hada bridge in the RCA, 1 (3.0%) in the diagonal arteries, and2 (6.0%) had deep bridges in the posterior descending artery.

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Table (1): Demographic characters of the patients:

Item	Stage of hypertension		P
	Stage 1	Stage 2	
Means age ± S.D	65.39±(12.38)	70.65±(12.70)	t=7.48*
Sex : Male / Female ratio	40 (66.67%) / 20 (33.33%)	35 (58.34%) / 25 (41.66)	X^2 = 3.24*
Hypercholesterol: Y/N	15 (25%) / 45 (75%)	10 (16.67 %)/ 50 (83.33 %)	X^2 =4.25*
Diabetes : Y/N	15 (25 %)/ 45 (75%)	20 (33.33 %)/ 40 (66.67 %)	X^2 =5.24*
Smoker : Y/N	15 (25 %)/ 45 (75 %)	13 (21.67%)/ 47 (78.33%)	X^2 =10.44*
Percentage	49	53	
Total number	60	60	

* = Significant at (P < 0.05)

Table (2): Superfacial and deep bridge uses among different types of hypertension.

Item	Stage of hypertension				Chi2-test	Significant
	Stage 1		Stage 2			
	No	%	No	%		
Superfacial bridge						
Proximal stenosis						
1	11	18.34	15	25	7.29	0.015 **
2	10	16.67	14	23.34		
3	9	15	11	18.34		
Deep bridge						
Proximal stenosis						
1	11	18.34	3	5	9.35	0.0018**
2	10	16.67	3	5		
3	9	15	4	6.67		

** = Significant at (P < 0.01)

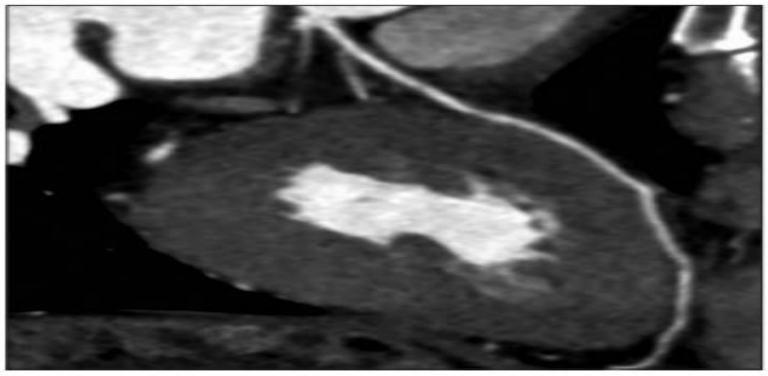

Figure 1: Superficial bridge with grade 1 stenosis in the artery proximal to the bridge

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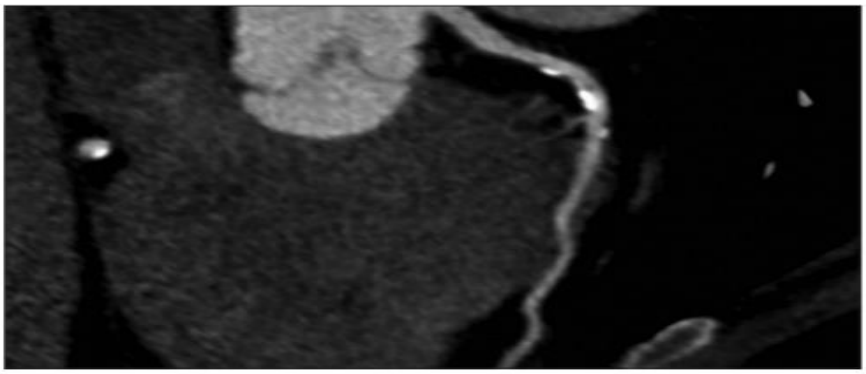

Figure 2: Deep bridge with grade 2 stenosis in the artery proximalto bridge

Stenosis and blood pressure

Among 120 patients, 66 (50%) had stage 1 hypertension and 60 (50%) patients had stage 2 hypertension. Of those myocardial superficial bridged patients in the stage 1 hypertension group [Table 1], patients were evenly spread across grades 1, 2, and 3 stenosis (9 to 11) patients each. In the stage 2 hypertension group, grade 2 type stenosis was most prevalent, affecting 10 ofthe patients.

Among the myocardial deep-bridged patients [Table 1] in the stage 1 hypertension group, patients were again evenly spread between the three grades of stenosis (9-11 patients each). In the stage 2 hypertensiongroup, stenosis was greatly reduced in comparison to allother groupings.

Statistical analysis:

The statistical analysis was carried-out using Chi^2-test for study the significance of the incidences of hypertension and type of stensosis incidnces among examined patients in stage I and stage II. Thestatistical analysis was carriedout using the SPSSPC+ computer program version 21.

DISCUSSION

Our results on the **demographic data** and the predisposing factor causing hypertension includes increasing the patient age, presence chronic diseases as dibetes, atheroscleosis, stage of hypertension I or II, somking. mainly in the stage 2 their age higher than the age of patientsin stage 1 as their age was 7065 year in stage 2 whil, in stage 1 reached to 65.39 year.

The male to female ration in patients in stage 1 higher than that of the stage 2, The hypercholesterol level in stage 1 higher than that of the stage 1 as it observed in 15 (25 %) of the patient in stage 1 , while, in patient in stage 2 observed in the 10 (16.67 %) of the patient in stage 2. The diabetes incidences in patient in stage-2 higher than that of the patient in stage-1 as it reached to 20 (33.33 %) in stage 2 and 15 (25 %) in patient in stage-1. The smoker in patient of stage-1 higher than that of the patient in stage-2 as their number in stage-1 were 15 (25 %) and 13 (21.67 %0 in stage-2. The incidence of hypertension in the stage-1 was 49 % and in stage 2 their incidence was 53 %.

This results agreed with those of **(Reda et al., 2021)** where they reported that, that in Egypt the most predisposing factors for hypertension includes , males (74%) and the most prevalent age group was (56-65 years) representing 37% of whole study population. Among female patients, 92% were post-menopausal. The prevalence of premature ACS was 51%. Forty five percent of total males and 69.6% of total females with ACS had premature presentation ($P<0.001$). Abdominal obesity was the most prevalent risk factor (66%). Nearly half of the entire study patients were current smokers (48%).

MB is an anatomical variation in which the artery is covered by either membranous or muscular myocardium. The golden standard method for diagnosing MB is coronary angiography; the detection rate using CAG is between 0.5% and 29.4**%.(Irvin et al., 1982)** If using CAG the detection depends on the thickness of the bridge, position of the artery, and adipose tissue covering the bridge. **(Moehlenkamp et al., 2002).** However with the advancement in computed tomography, a noninvasive procedure, the detection rate is 3.5%-58%, which is a broader and has higher detection rate than CAG. **(Noble et al., 1976).** The detection rate of MB is higher, if the number of detectors in

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MDCT is increased because smaller MB can be detected. **(Ko et al., 2008),** the increased spatial and contrast would make the visibility more clear and would ease in the diagnosis of MB.

Our study cleared that, among the 120 patients, superficial bridges were the most common type of bridge. The mean average length of the bridge was 10.26 mm and among these patients,60 (89.56%) of superficial bridges were in the LAD artery.The most common location of the bridge in the LAD wasin the middle segment (> 80%) of the artery, while the second most common location was the proximal part ofthe artery. Among these 67 superficial bridges, 3 (4.48%)were located in RCA and 2 (2.98%) in the diagonal arteries. While, in **Deep bridge** there were 46 (38.34%) patients (out of 120) suffering frommyocardial deep bridge and the mean lengthand depth of these bridges were 7.14 and 4.29 mm, respectively. More than 90% of the bridge was found in the middle segment, while the remainder was in the proximal segment, of 38 deep bridge patients, 34 (89.4%)patients had bridges in the LAD artery, 1 (3%) patient hada bridge in the RCA, 1 (3.0%) in the diagonal arteries, and2 (6.0%) had deep bridges in the posterior descending artery.

The results of this study indicating that superficial bridges are most common **(Ishii et al., 1998).** LAD was the most common location of MB and artery involved, withMBs occurring mostly in the middle segment and less so in the proximal part**. (Zeina et al., 2007).** No artery was found to have two bridges. The mean length of the superficial and deep bridges was found to be 10.26 and 7.14 mm, respectively,whereas the mean depth of the deep bridge was found to be 4.29 mm.

Atherosclerosis was present in the artery proximal to the bridge and resulted in stenosis thereby decreasing the blood flow to the myocardium. There was no sign of atherosclerosis in the tunneled artery beneath the MB and in the distal part of the artery. **(Kim et al., 2008).** However, there is high shear stress in the tunneled artery and reduced vasoactive secretion, so that the artery is free from atherosclerosis. **(Masuda et al., 2001).** The low shear stress at the proximal part of the artery may cause lipid transfer across the arterial membrane which could lead to atherosclerosis formation. **(Caro et al., 1971).**

Endothelium is a thin layer lining the interior of blood vessels. It is an important source of mediators like nitric oxide (eNOS), endothelin-1 (ET-1), throboxane H2, and prostoglandin A2. The normal function of these vasoactives (increase or decreases the blood pressure) is to contribute to the relaxation and contraction of the artery. In the case of damage to the endothelium due to high blood pressure, this could lead to narrowing and atherosclerosis initiation due to the improper secretion of these mediators by the damaged endothelium **(Vallance and Chan et al., 2001).** In the early stages of a dysfunctional endothelium, it causes macrophage attraction and adhesion. There is also accumulation of oxidized lipid leading to fatty streaks.

In previous research, it has been found that in MB, there is impaired vasoactive secretion of mediators such as eNOS, angiotensin converting enzyme, ET-1 in the artery proximal to the bridge **(Lerman et al., 1991).** The intimal thickness of the tunneled artery and permeability is reduced, whereas incontrast permeability in the artery proximal to the bridgeis found to be increased.

An increase in blood pressure and turbulent blood flow may result in increased pressure on the intima of the artery proximal to bridge resulting in injury to the intima. This causes platelet aggression and vasospasmof the coronary artery **(Ciampricotti et al., 1988).** The injured intima forms into scars, causing cholesterol and other substances to become lodged onto the scar, and results in narrowing and plaque formation.

It has been documented by using intravascular ultrasound that there is high arterial pressure in the artery proximal to the bridge as compared with thatof the aorta. It has been said in the previous studies that increases in pressure, blood flow disturbances andhigh wall stress in the artery proximal to bridge are the main cause for the development of atherosclerosis resulting in stenosis. **(Ge et al., 1999)**. Impaired vasoactive mediator secretion, resulting in a narrowing of the artery. Both these mechanisms can result in stenosis of the affectedartery, thereby reducing the blood flow.

This study concluded that, the main predisposing risk factors for hypertension includes , male is more susceptable than female, hypercholesterol, diabetes, smoking. Also, there was strong evidence of atherosclerosisin the proximal part of the artery, while the bridged andtherefore tunneled artery showed no atherosclerosis. Theresults of this research, therefore, indicate that there isno significant relationship between the MB and stenosisin hypertensive patients.

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