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ISOLATED MYOCARDIAL BRIDGING: A POTENTIAL CAUSE OF SUDDEN CARDIAC DEATH IN THAILAND

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Abstract: *Introduction.* The clinical significance of myocardial bridging (MB) as a potential cause of death has been debated. There is inconsistency in prevalence reports of MB as a cause of death in sudden cardiac death (SCD). We aimed to identify the prevalence of MB as a potential cause of SCD in non-ischemic heart disease (non-IHD) in Asian population.

Methods. The SCD autopsy reports from Bangkok, Thailand between January 2012 and June 2014 were included. External causes, drug toxicity, and inconclusive autopsies were excluded. Conventional risk factors were recorded and compared between MB and non-MB.

Results. Among 1,152 autopsy reports, 138 cases (85.5% male) were considered as SCD. 111 cases (80.4%) were caused by ischemic heart disease (IHD) whereas 27 cases (19.6%) were not (non-IHD). In IHD, the causes of death were coronary atherosclerosis, acute myocardial infarction, and old myocardial infarction (41.4, 34.2, and 24.3%). In non-IHD, MB was the most common pathological finding of SCD, followed by isolated left ventricular hypertrophy, hypertrophic cardiomyopathy, and myocarditis (29.6%, 25.9%, 22.2% and 14.8%). There were more males in both groups (MB [87.5%], non-MB [85.4%]). Mean (SD) heart weight of MB was lower than non-MB, [345.0(49.6) *vs*. 444.0(108.6) g, p=0.012]. There was no difference in mean age and body mass index.

Conclusions. Our study suggested that MB might be a potential cause of SCD in non-IHD Asian population and highlights the mortality in asymptomatic MB patients.

Key words: myocardial bridging, sudden death, forensic medicine.

INTRODUCTION

Myocardial bridging (MB) is a congenital coronary anomaly in which a segment of coronary vessels is embedded into myocardium tissue. The incidence varies, depending on the diagnostic evaluation method, up to 16% when assessed by angiography [1] and 80% in some autopsy series [2, 3]. In sudden cardiac death (SCD) autopsy series, left anterior descending coronary (LAD), particularly the proximal segment, is the most common affected vessel in MB. However, several studies report involvement of multiple segments of MB in the same or different coronaries [1, 2, 4, 5].

As the majority of coronary blood flow occurs only during diastolic phase, delayed relaxation in MB during diastolic phase is responsible for coronary blood flow reduction [1, 4, 6]. This pathophysiology plays an important role in the lethal consequences of this anomaly. The coronary obstruction of MB has been classified into either benign or pathologic according to their location, intra-myocardial length, and intra-myocardial depth. Pathologic MB is considered if the bridging segment is 20–30 mm long and 2–3 mm deep [2]. In some cases, pathologic MB may cause ischemia, infarction, malignant ventricular arrhythmias, and eventually SCD [2, 5, 7, 8]. However, there was a case report in which the evidence of ischemia and infarction were found despite benign MB [2] affirming that the clinical consequences do not depend on the degree of coronary blood flow reduction.

Although MB has been recognized for decades, the clinical significance of MB as a potential cause of SCD remains a subject of debate. According to previous studies, the probability of MB in Caucasian population

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as the only potential cause of SCD was quite low [1-3]. To our knowledge, there is no study which demonstrated MB as the potential common cause of SCD in an Asian population. Hence, we aimed to identify the prevalence of MB in an Asian population, reviewed the potential relation between MB and conventional risk factors, and identified cardiovascular events to establish the understanding of the clinical implications of MB.

MATERIALS AND METHODS

The autopsy reports of patients age 18-64 years performed in the division of forensic pathology, Ramathibodi Hospital, Mahidol University, Thailand, between January 2012 and June 2014, were analyzed. The autopsies were individually performed by forensic pathologists. All reports were reviewed by one forensic pathologist. About the autopsies, all tissue samples including brain, aorta, heart, lung, liver, spleen, pancreas, adrenal glands, and kidneys were examined grossly and histologically. Three main coronary arteries and left main branch were serially sliced at 5 mm thickness and were examined for atherosclerosis and myocardial bridging. Left ventricular walls were also serially sliced at 5 mm thickness and were grossly and histologically examined for infarction and other diseases. Right ventricular walls were also serially sliced and were examined grossly and histologically. At least 2 sections of left ventricle and 1 section of right ventricle were histologically examined. Comprehensive drug screenings in blood for 1700 drugs, including amphetamine, opioids, and cocaine were performed. Blood alcohol tests were also done.

SCD was considered when death occurred within 1 hour of the acute onset of symptoms or the person was last seen alive within 24 hours before death occurred [9, 10]. All other causes of death were excluded (including expected death, drug intoxication, trauma, and external causes).

These cases were further subdivided into two main groups, group 1: SCD cases with ischemic heart disease (IHD) and Group 2: SCD cases without any ischemic changes in cardiac tissue or significant atherosclerosis (non-IHD). IHD was identified by the ischemic change in cardiac tissue either during gross or histological examination, or significant coronary arthrosclerosis more than 70% in at least one coronary artery. Pathologic MB was considered if the bridging segments were 2–3 mm deep. MB is considered as the potential cause of SCD if no other potential causes of death were identified such as left ventricular hypertrophy, myocarditis, cardiomyopathy, arrhythmogenic right ventricular dysplasia.

Demographic data, included age at death, sex, and body mass index, were reviewed. Body mass index was categorized according to the World Health Organization classification.

Continuous variables (age and BMI) were evaluated by t-test. The $\chi 2$ test was used to compare categorical variables between two groups. $P<0.05$ was used as the level of statistical significance.

RESULTS

Among 1,152 autopsy reports, 138 cases (85.5% male) were considered as SCD. There were 111 cases (80.4%) caused by IHD and 27 cases (19.6%) were non-IHD. In IHD, the causes of death were coronary atherosclerosis, acute myocardial infarction, and old myocardial infarction (41.4, 34.2, and 24.3%, respectively). In non-IHD, MB was the most common pathological finding of SCD followed by isolated left ventricular hypertrophy, hypertrophic cardiomyopathy, and myocarditis. (29.6, 25.9, 22.2 and 14.8%, respectively). All of the MB were located at the LAD. The autopsy findings of myocardial bridging were shown in the Figure 1. The anatomical characteristics of eight MB cases were reviewed and summarized in Table 1. Male sex predominated in both MB (87.5%) and non-MB (85.4%) groups. Mean (SD) heart weight of MB was lower than non-MB, [345.0(49.6) *vs*. 444.0(108.6) g, p=0.012], as well as coronary artery atherosclerosis (0.0% *vs*. 76.9%, p<0.001). There was no difference in mean age and mean body mass index.

DISCUSSION

A diverse range of symptoms have been observed in the presentation of MB, including angina-like chest pain, myocardial infarction, acute coronary syndrome, arrhythmias (including supraventricular tachycardia and ventricular tachycardia), and sudden cardiac death [11]. The significance of MB as a potential cause of SCD has been a controversial issue for decades [11]. Several studies reported low frequency of MB as a potential cause of SCD in only Caucasian population [12-14], whereas recent screening studies by computed tomography coronary artery angiogram and intravascular ultrasound demonstrated high prevalence of MB in Asian populations [1-3]. This emphasizes that the study of MB in Asian-population is crucial.

Although the frequency of MB as an isolated

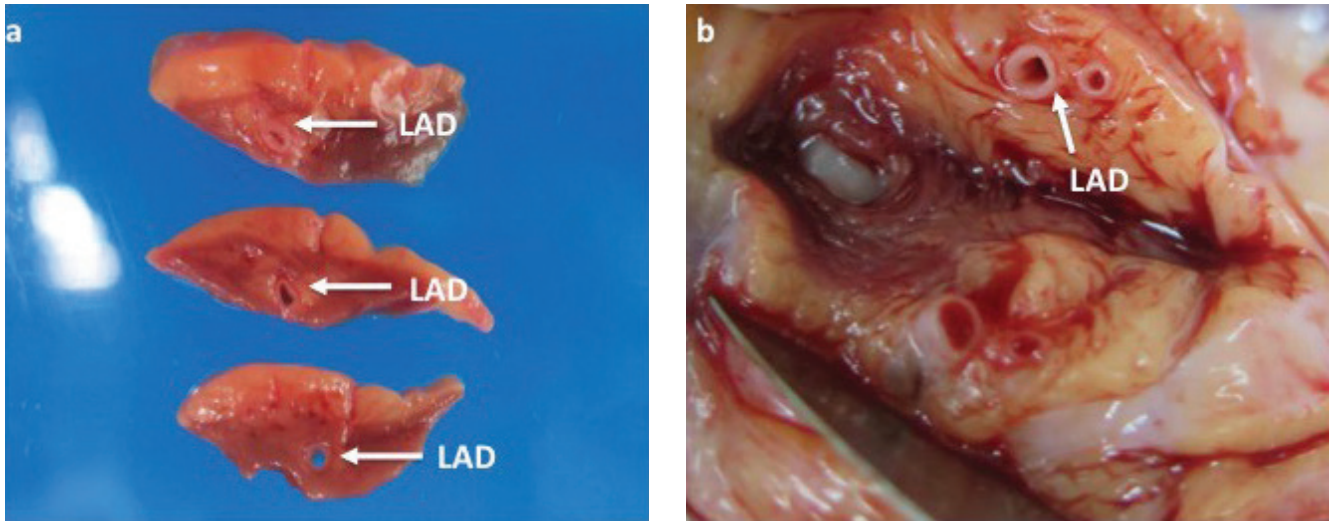

Figure 1. Bridging of the left anterior descending artery [LAD] seen in sudden cardiac death [SCD] autopsy studies (panel a) compared with normal anatomy of LAD in SCD autopsy studies (panel b).

Table 1. Anatomical characteristics of eight myocardial bridging

Case	Gender/Age	MB Site	From Vessel origin (cm)	MB length (cm)	MB depth (cm)
#1	F/51	LAD	N/A	N/A	0.2
#2	M/43	LAD	7	2.2	0.3
#3	M/47	LAD	5	1.2	0.2
#4	M/38	LAD	5	1.2	0.2
#5	M/44	LAD	N/A	N/A	0.5
#6	M/59	LAD	N/A	N/A	0.3
#7	M/54	LAD	N/A	N/A	0.4
#8	M/24	LAD	5	3	0.5

MB = Myocardial Bridging; LAD = Left Anterior Descending; N/A = Not Available; M = Male; F = Female.

cause of SCD is extremely low, prognostic risk identification of SCD in MB is crucial Previous studies have identified the association between the morphological changes of MB and the risk of SCD including depth, angulation, and position [15]. Morphological changes in MB that are symptomatic and can potentially lead to SCD through a primary ischemic or electrical effect is also known as hemodynamically significant myocardial bridging (HSMB) [15]. MB is considered to be HSMB when at least one of these criteria is present: 1) coronary artery bridge's depth more than 2 mm, 2) atherosclerosis present proximal to the bridging area and absent distal from the bridging area, or 3) distal hypoplasia [15].

Reduction of coronary blood flow and perfusion in HSMB is the primary pathophysiology of both ischemic and electrical events that can lead to SCD [15]. They are aggravated by tachycardia, proximal atherosclerosis vasospasm, or acute thrombosis at other coronary arteries [15, 16]. The reduction of perfusion sometimes is not significant enough to cause ischemic changes. However, it is significant enough to induce myocardial remodeling [15]. Myocardial remodeling increases the chance of electrical instabilities, such as prolonged QTc, which can lead to the fatal ventricular arrhythmias [15].

This study highlights the potential association between morphological changes of MB and SCD. According to the classification of HSMB based on the length and depth of the bridging, all of 8 SCD caused by MB in our study were considered to be a pathological anomaly or HSMB. Furthermore, there was no histological or anatomical evidence of myocardial infarction that were identified in these cases of MB. These findings suggest that primary electrical events could be the main pathophysiology of SCD in MB.

In our autopsy results, one case (case number 8, in Table 1) presented with pathologic MB over LAD. Other potential causes of death (atherosclerosis, myocardial infarction, LVH, and hypertrophic cardiomyopathy) were not identified. Interestingly, hemorrhagic gastritis was identified in the autopsy. Since hemorrhagic gastritis can cause significant bleeding and thus induce tachycardia, ventricular

arrhythmia through primary electrical effect was thought to be the cause of SCD. Moreover, our autopsy findings revealed no malignant aggravating factors that could potentially cause coronary blood flow reduction in every other case. These negative findings strongly suggest that arrhythmia or primary electrical effect is the main pathophysiology of SCD in MB.

In conclusion, our study is the first prevalence study of MB in SCD autopsy reports among an Asian population. This study also suggests that MB can potentially be a common cause of SCD in non-IHD patients. Our findings also highlight the awareness of mortality in asymptomatic MB patients in an Asian population. Further study of MB prevalence in SCD, primary prevention, and treatment of MB should be emphasized. Pathologic lesions, based on the length, and depth of bridging should be highlighted to prevent related adverse events such as myocardial infarction, malignant arrhythmia, and eventual SCD.

Conflict of interest

The authors declare that they have no conflict of interest.

Limitation

We could not definitely conclude that myocardial bridging artery is the cause of sudden cardiac death since we could not exclude arrhythmic cause in the non-ischemic group. Since this study is a retrospective study and the limited resources at the time of autopsy, the molecular testing for channelopathies has not been done. The further study with additional molecular testing in autopsy-negative sudden cardiac death is recommended.

Ethical statement

The protocol has been approved by the Ethics Committee of the institution within the research work was performed.

References

1. Alegria JR, Herrmann J, Holmes DR, Jr., Lerman A, Rihal CS. Myocardial bridging. Eur Heart J. 2005;26(12):1159-1168.
2. Hill SF, Sheppard MN. Non-atherosclerotic coronary artery disease associated with sudden cardiac death. Heart. 2010;96(14):1119-1125.
3. Mohlenkamp S, Hort W, Ge J, Erbel R. Update on myocardial bridging. Circulation. 2002;106(20):2616-2622.
4. Erbel R, Ge J, Mohlenkamp S. Myocardial bridging: a congenital variant as an anatomic risk factor for myocardial infarction? Circulation. 2009;120(5):357-359.
5. Lilly LS BE, Bonow RO. Braunwald's heart disease: a textbook of cardiovascular medicine: Elsevier Saunders; 2012.
6. Bourassa MG, Butnaru A, Lesperance J, Tardif JC. Symptomatic myocardial bridges: overview of ischemic mechanisms and current diagnostic and treatment strategies. J Am Coll Cardiol. 2003;41(3):351-359.
7. Marchionni N, Chechi T, Falai M, Margheri M, Fumagalli S. Myocardial stunning associated with a myocardial bridge. Int J Cardiol. 2002;82(1):65-67.
8. Priori SG, Aliot E, Blomstrom-Lundqvist C, Bossaert L, Breithardt G, Brugada P, Camm AJ, Cappato R, Cobbe SM, Di Mario C, Maron BJ, McKenna WJ, Pedersen AK, Ravens U, Schwartz PJ, Trusz-Gluza M, Vardas P, Wellens HJ, Zipes DP. Task Force on Sudden Cardiac Death of the European Society of Cardiology. Eur Heart J. 2001;22(16):1374-1450.
9. Basso C, Burke M, Fornes P, Gallagher PJ, De Gouveia RH, Sheppard M, Thiene G, Van Der Wal A; Association for European Cardiovascular Pathology. Guidelines for autopsy investigation of sudden cardiac death. Pathologica. 2010;102(5):391-404.
10. Davies MJ. The investigation of sudden cardiac death. Histopathology. 1999;34(2):93-98.
11. Garcia-Alberola A, Yli-Mayry S, Block M, Haverkamp W, Martinez-Rubio A, Kottkamp H, Breithardt G, Borggrefe M. RR interval variability in irregular monomorphic ventricular tachycardia and atrial fibrillation. Circulation. 1996;93(2):295-300.
12. Desseigne P, Tabib A, Loire R. [Myocardial bridging on the left anterior descending coronary artery and sudden death. Apropos of 19 cases with autopsy]. Arch Mal Coeur Vaiss. 1991;84(4):511-516.
13. Morales AR, Romanelli R, Tate LG, Boucek RJ, de Marchena E. Intramural left anterior descending coronary artery: significance of the depth of the muscular tunnel. Hum Pathol. 1993;24(7):693-701.
14. Eckart RE, Scoville SL, Campbell CL, Shry EA, Stajduhar KC, Potter RN, Pearse LA, Virmani R. Sudden death in young adults: a 25-year review of autopsies in military recruits. Ann Intern Med. 2004;141(11):829-834.
15. Hostiuc S, Curca GC, Dermengiu D, Dermengiu S, Hostiuc M, Rusu MC. Morphological changes associated with hemodynamically significant myocardial bridges in sudden cardiac death. Thorac Cardiovasc Surg. 2011;59(7):393-398.
16. Feld H, Guadanino V, Hollander G, Greengart A, Lichstein E, Shani J. Exercise-induced ventricular tachycardia in association with a myocardial bridge. Chest. 1991;99(5):1295-1296.