Case Study

Aeromedical Fitness Considerations in Myocardial Bridging: A Case Study and Literature Review

Aims:
Management of cardiac disease in aeromedical expertise can be challenging for asymptomatic crew members, especially during the first aeromedical examination, myocardial bridging is a good example.

Presentation of Case: A 24-year-old student pilot candidate showsrepolarization disorders at the ECGin the aeromedical examination, the exploration allowed the discovery of a myocardial bridge on The Coronary computed tomographic angiography (CCTA) of the left anterior descending (LAD) coronary artery responsible for tight stenosis.

Discussion:
the prevalence of MB varies according to the method of investigation, ranging from 2% in coronary angiography and 19% in coronary computed tomography to 42% in autopsy.The prevalence among active civilian aircrew (pilots and cabin crew) monitored at CEMPN is 0.4%, all revealed by electrocardiogram abnormalities.

MB are usually small and of no clinical significance, the myocardial bridgeproximal segmenthas been associated with atherosclerosis.Symptomatic patients with myocardial bridges as their only cardiac abnormality may present with myocardial ischemia, acute coronary syndromes, coronary spasm, syncope or even sudden death.

The initial therapeutic strategy in the treatment of MB is medical management. Revascularization is indicated by PCI or surgery, including coronary artery bypass grafting (CABG) or myotomy in the case of symptoms recalcitrant to maximal medical treatment.

The aviation environment may expose aircrew to additional physiological stressors, including hypobaria, hypoxia and sustained acceleration (+Gz). Such exposure may present a risk if associated with cardiovascular abnormalities, potentially leading to incapacity to fly due to symptoms or complications of the myocardial bridge.

Conclusion: the myocardial bridge is an anatomical variant rather than a congenital anomaly with varied symptomatology (ECG abnormality, stable or unstable angina or sudden death), the aeromedical decision is made on a case-by-case basis, and makes a challenge diagnostic, particularly for asymptomatic crews.

Keywords: Myocardial bridging,aeromedical expertise,aeromedical fitness

INTRODUCTION:

"Myocardial bridging (MB) is a congenital coronary anomaly in which a segment of the epicardial coronary artery traverses through the myocardium for a portion of its length" [1]. *(figure 1)*

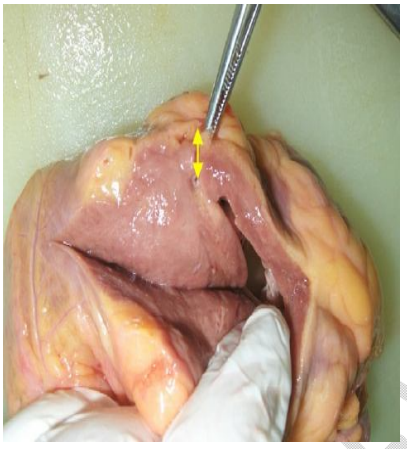


Figure 1: Sagittal section of the left anterior descending artery showing the myocardial bridge at its middle part [2]

"Generally benign and asymptomatic, MB can alter coronary blood flow during exercise, depending on the length and depth of the tunneled artery, and can have significant aeromedical ramifications, exceptionally leading to serious, life-threatening complications"[1,3].

CASE PRESENTATION:

A 24-year-old student pilot candidate came to the Aeromedical Expertise Center of Rabat (CEMPN) for medical evaluation.

He had no previous medical comorbidities and was asymptomatic. The physical examination was unremarkable,the ECG revealed repolarization disorders in the anterior area.The transthoracic echocardiography shows no abnormality.The exercise stress testing was negative clinically and suspicious electrically (ST depression regressing in recovery).

The CCTA revealed non-calcified coronary arteries, with long intramyocardial path of the middle and distal left anterior descending (LAD) coronary artery responsible for tight stenosis. Coronary angiography shows non-atheromatous coronary arteries, milking of the distal LAD (figure 2), downstream the artery is of very small caliber, the right coronary is dominant and of large caliber and ensure the vascularization of the apex in place of the LAD. The length of the bridges was 50 mm and its thickness was 1.25 mm. Antiplatelet therapy was indicated to the patient.

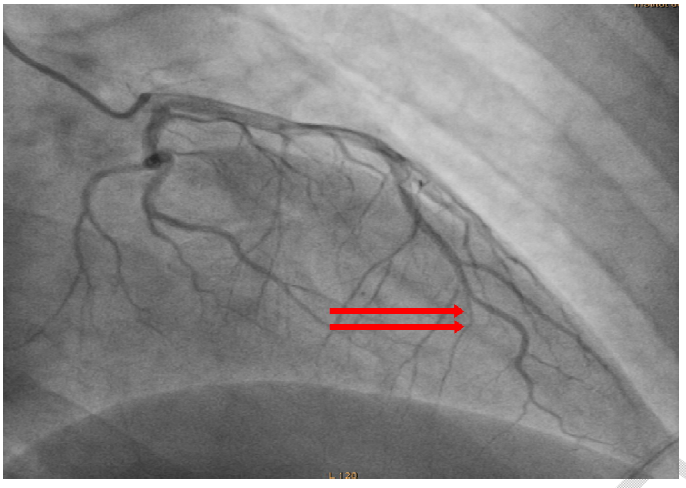


Figure 2: Milking of the distal LAD artery in Coronary angiography

DISCUSSION:

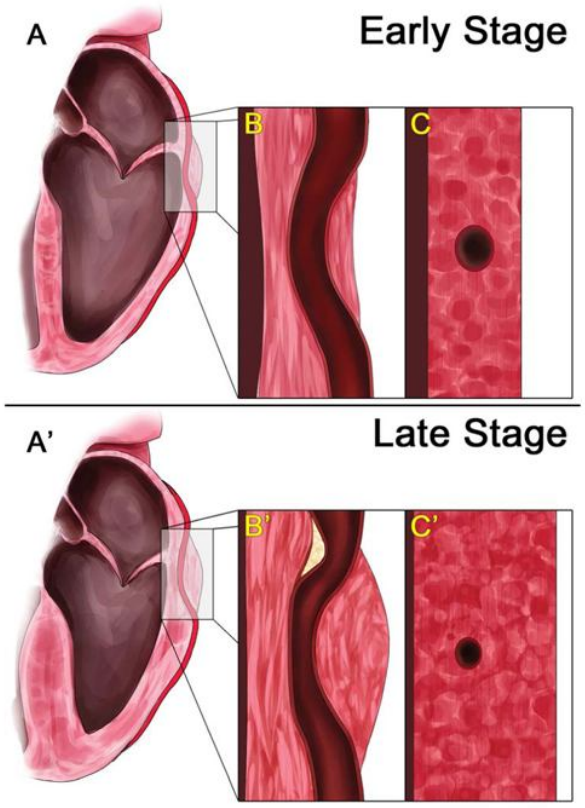
"First described by Reyman in 1737.The true prevalence of MB is not precisely known, varying according to the search method, from 2% on coronary angiography and 19% on coronary CT to 42% on autopsy. Myocardial bridges can be found in any epicardial artery, with 67-98% of them in the left anterior descending (LAD) coronary artery" [1,4].

"The anatomic features of the bridges vary significantly with a thickness of 1.0-3.8 mm, a length of 2.3-42.8 mm and an angle between long axis of muscle fibers and long axis of the crossed vessel of 5°-90°. It was reported that the mean length of the bridges was 14.64±9.03 mm and the mean thickness was 1.23±1.32 mm" [5,6]

"Myocardial bridges are usually small and of no clinical significance, the proximal segment of the myocardial bridge has been associated with atherosclerosis rather than the myocardial bridging segment itself" [7]

"The mechanical stress caused by systolic narrowing at the myocardial bridging segment may result in endothelial damage, which, conversely, may induce platelet aggregation, coronary vasospasm and eventually acute coronary syndrome. Both hemodynamic and structural changes, such as blood flow disturbance, myocardial malperfusion, deposits of lipids and mucopolysaccharides and elastic damages, can be noted in the proximal coronary arterial segment of a myocardial bridge" [1].

"All these changes predispose to formation of atherosclerotic plaques in the intima of the coronary artery segment. Obviously, myocardial bridging is associated with degenerations of both myocardium and coronary artery" [3, 7]. (Figure 3)



A: Heart with myocardial bridging, early stage. ***B:*** Longitudinal view of the bridged vessel. ***C:*** Cross-sectional view of the vessel in the middle of the myocardial bridge. ***A':*** Heart with myocardial bridging, late stage, with ventricular hypertrophy and diastolic dysfunction. ***B':*** Longitudinal view of the bridged vessel, with hypertrophied muscle and plaque progression proximal to the bridge. ***C':*** Cross-sectional view of the vessel in the middle of the myocardial bridge showing hypertrophied muscle and the negative remodeling of the vessel with decreased lumen diameter. Images were drawn by Clare Wang.

Figure 3: **Schematic Diagram of the Effects of Aging on the Myocardial Bridge [1]**

"Symptomatic patients whose only cardiac abnormality is myocardial bridging may present with coronary spasm, exercise-induced dysrhythmias like atrioventricular conduction block, supraventricular tachycardia, ventricular tachycardia, acute coronary syndromes, myocardial ischemia or even sudden death" [8]

"The use of CCTA to study chest pain syndromes has developed rapidly. The advantage of CCT lies in its high spatial resolution and its ability to easily visualize in three dimensions, both coronary artery lumen and all surrounding structures, enabling accurate assessment of the vessel wall and surrounding myocardium, as well as the lumen" [6,9].

"A number of invasive techniques can be used in the catheterization laboratory to assess MB in detail, including angiography, IVUS (intravascular ultrasound), OCT (optical coherence tomography), Doppler flow wire (DFW) and pressure wire techniques.The most commonly observed angiographic finding of MB is the systolic narrowing or "milking" of the vessel. This is accompanied by a "step-down" and "step-up," which delineate the affected coronary segment with either complete or partial decompression in diastole"[9, 10]

“Intravascular ultrasound (IVUS) has been employed in a multitude of studies in the angiographic evaluation of myocardial bridging (MB). The three-dimensional visualization of the anatomy at the site of MB enables precise measurements of the lumen diameter and vessel wall morphology. The hallmark finding is the "half-moon" sign, which represents an echolucent area immediately adjacent to the vessel lumen and persisting throughout the cardiac cycle” [10]

The treatment of symptomatic MB remains a significant clinical challenge. A comprehensive approach that considers the individual patient's symptoms, coronary and cardiac anatomy, degree of ischemia, and comorbid conditions (the presence of hypertrophic cardiomyopathy,CAD, valvular heart disease or other cardiomyopathies) is essential, as these factors may significantly influence the outcomes of patients with MB [11].

“The elevated risk of atherosclerosis in patients with myocardial bridging underscores the necessity of considering antiplatelet therapy, even in the absence of symptoms. For patients presenting with symptoms, beta-blockers remain the primary conservative treatment option, relieving patients of hemodynamic impairment. Calcium channel blockers may exert beneficial vasodilatory effects in the context of concomitant vasospasm” [12,6]

“In symptomatic patients with myocardial bridges, the implantation of a stent may provide relief from systolic coronary compression and improve overall patient condition. However, the potential complications associated with both the coronary artery and the stent itself have limited its use”[12,5]

“Surgical intervention may entail either supra-arterial myotomy or coronary artery bypass. The latter is indicated for patients presenting with extensive (>26 mm) or deep (>6 mm) myocardial bridging, or when the tunneled coronary segment is unlikely to be completely decompressed during diastole” [13]

“The prevalence among active civil aircrew (pilot and cabin crew) monitored at the CEMPN is 0.4%, with all cases revealed by electrocardiogram abnormalities. The ECG is systematically carried out at each medical evaluation” [14].

The aviation environment may expose aircrew to additional physiological stressors, including hypobaria, hypoxia and sustained acceleration (+Gz). Such exposure may present a risk if associated with cardiovascular abnormalities, potentially leading to incapacity to fly.[15]

AEROMEDICAL ASSESSMENT AND FITNESS FOR DUTY

The flight crew represents a selected population that is medically monitored. They must meet medical fitness conditions that are subject to regulatory standards. These vary according to the category of the crew members. They nevertheless serve the same objective, which is to ensure the safety of flights and the transported individuals, as well as the fulfillment of missions.

“International standards are ruled by the aviation medicine manual published by the International Civil Aviation Organization,wich indicate that the candidate must not have any

congenital or acquired heart anomalies,that could prevent them from safely exercising the privileges of their license and qualifications" [16]

The routine aircrew examinations conducted at the CEMPN include a comprehensive medical history, a detailed family history, a physical examination, and a systematic 12-lead ECG.

"A considerable number of diagnoses of congenital heart disease, whether native or corrected, are associated with the presence of abnormal electrocardiogram (ECG) findings. In such cases, further investigation may be warranted, and the individual may be subject to restrictions or the withdrawal of their flying privileges. Cardiovascular pathologies represent the fourth leading cause of unfitness (9%) during periodic medical examinations" [14]

The aeromedical fitness depends on several conditions:

- Discovery mode: symptomatology or complication
- Aircrew function:monitor, single-pilote
- Cardiovascular risk factors : stress, smoking, diabetes, hypertension, dyslipidemia, obesity, family history
- First or periodic medical evaluation
- Treatementcomputability

The characteristics of the myocardial bridge, the significant modification of the vascularization of the heart exposes in our case to a serious risk of complications especially for a first time examination,the decision was unfitness.

CONCLUSION:

the myocardial bridge is an anatomical variant rather than a congenital anomaly with varied symptomatology (ECG abnormality, stable or unstable angina or sudden death).Aircrew with myocardial bridging mandates a detailed assessment.In order to make an informed decision regarding the employability of aircrew, it is essential to have a comprehensive understanding of the potential or current occupational roles, the environmental physiology, and a specific risk assessment. The aeromedical fitness depends on several conditions and the decision is made on a case-by-case basis.

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As per international standards or university standards, patient(s) written consent has been collected and preserved by the author(s).

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