Myocardial Bridges: A Prospective Forensic Autopsy Study

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SUMMARY

Introduction When the coronary artery, located subepicardially, submerges into the myocardium and appears again subepicardially after a short intramural course, it represents an embedded coronary artery, while the part of the myocardium above is a myocardial bridge.

Objective We investigated the frequency of the embedded left coronary artery (LAD) in the autopsy material considering the descending branch of the LAD to be the most important one in the nourishment of the myocardium and myocardial bridges to be the most frequent in its area, as well as clinically important.

Methods A prospective autopsy study of 975 cases was performed, including both, natural (21.33%) and violent (78.67%) deaths. The sample consisted of 74.56% males and 25.44% females. In order to discover myocardyal bridges and their characteristics, the hearts were examined by both transverse cuts and longitudinal openings of the LAD.

Results Myocardial bridge was found in 78 cases (8.00%), more commonly in males (9.35%) than females (4.03%). The average length of the myocardial bridge was 21.85±16.10mm and thickness 3.744±1.48 mm. The common localization of the myocardial bridge was the proximal half of the LAD (89.74%). The upper part of the artery, proximal to the bridge, was a common site of atherosclerotic changes. Myocardial bridge was found in 12.50% of natural deaths, but in 13.38% out of all cases of sudden cardiac deaths.

Conclusion Therefore, the presence of the myocardial bridge by itself is not predominant, but it is certainly a contributing factor to a sudden cardiac death.

Keywords: myocardial bridge; forensic autopsy study; manner of death

INTRODUCTION

Embedded coronary is one of the congenital variations of arterial blood vessels of the heart and represents atavism. The coronary artery is submerged into the myocardium and after a short intramural flow reappears in the subepicardial fat tissue. The section of the myocardium above the embedded coronary is called a myocardial bridge (coronary artery overbridging) [1-4]. The myocardial bridge is situated almost exclusively above the front left descendent coronary artery (LAD) and much less (in percentages) on the circumflex – DCA and the right coronary arteries – RCA [5, 6]. The LAD vascularizes the front section of the chamber partition and the lateral wall of the left chamber, however its branches vascularize the bundle of Hiss.

Myocardial bridges are usually small and have no clinical significance. If they become thicker they might show various symptoms: angina pains, tachyarrhythmia; they can also lead to the infarct of the myocardium and a sudden death. It is believed that symptoms associated with a coronary ischemia are the result of either a compression of the coronary artery by the myocardial bridge during a systole or delayed relaxation of the artery during a diastole or both [7, 8]. It is also believed that a change of the blood flow, characteristic of these anatomic changes of the artery, has a considerable effect.

Bridging of the left coronary artery occurs more often in people with a dominant left coronary artery and with wider myocardial bridges; the artery lies deeper than in cases where the right side is dominant. When the myocardial bridges are present, there might be a certain degree of coronary artery stenosis in the systole; these are places where an arteriosclerotic process is localized more often.

OBJECTIVE

Considering the descending branch of the left coronary artery (LAD) to be the most important one in the nourishment of the myocardium, the myocardial bridges are most frequent in its area and therefore could have forensic importance, we investigated the frequency of the embedded LAD in the autopsy material.

METHODS

A prospective study of 975 autopsy cases was carried out at the Institute of Forensic Medicine, School of Medicine in Belgrade. Different to other similar studies where myocardial

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Figure 1. Longitudinal section of the intramural LAD

bridges have been observed in a group of natural coronary deaths, our sample was defined in the way where all samples, regardless of the cause of death, were analyzed.

The frequency of myocardial bridges above the descending branch of the left coronary artery was defined in the overall population in such a way that, regardless of the cause of death, a group was established out of the whole sample, in which myocardial bridges were found.

In order to establish the number of myocardial bridges as well as their exact place and size, during dissections, the LAD was cut open along the whole length (Figure 1) alongside the standard technique (cross sections at 5 mm intervals). The length and the thickest part were measured in every detected myocardial bridge. The type of heart vascularization was established as well as any pathological change in the myocardium. Localization and degree of atherosclerotic changes on the LAD were also determined. The role of the myocardial bridge was analyzed in relation to other predisposed factors (gender, age and circumstances of each individual case).

The following statistical procedures were used: χ^2 test, 2-way analysis of variance (ANOVA), Pearson's product-moment, and Spearman's rank-order correlations. The p value smaller than 0.05 from statistical procedures where considered significant, and values ranging from 0.1 to 0.05 as marginally significant.

RESULTS

The analyzed sample of 975 cases of autopsy consisted of 248 women (25.44%) and 727 men (74.56%) thus making men statistically considerably more represented whilst the age distribution was even. Out of 975 cases, the myocardial bridge was found in 8% (78) of the bodies where the post-mortem was carried out – in the group where natural deaths occurred 12.50% and in violent deaths 6.78% (χ^2=7.1571, df=1, p=0.0075). The existence of the myocardial bridge was noticed to appear significantly more frequently in men (9.35%) than in women (4.03%) (χ^2=7.1143, df=1, p=0.0076) in middle-aged and older people. Such differences in the frequency of myocardial bridge presence in different age groups reached the level of a marginal statistical value (χ^2=20.9801, df=12, p=0.0507). The average age in the group of 78 individuals with the myocardial bridge was 51.88±2.02 years, while the average age in the group of 897 individuals without the myocardial bridge was 50.34±0.65 years.

In relation to the manner of death, in 208 cases death occurred naturally (21.33%) and in 767 cases violently. Proportional representation of the tested individuals, according to their gender in relation to their death, was tested with the χ^2 test (χ^2=3.9655, df =1, p=0.0464); it showed that men were statistically more represented than women in all post-mortem materials, as well as in both groups of violent and natural deaths. Out of 208 natural deaths, 61.1% or 127 cases were sudden deaths due to heart failure.

The myocardial bridge is most often represented in the upper half (upper and middle third) of the LAD (89.74%), while in the lower half of the artery the myocardial bridge is represented in 10.26% (only isolated myocardial bridges were found).

In our sample a minimal length of the myocardial bridge was 5, maximal 70 mm; the average length was 21.85±16.10 mm without any statistically significant gender differences (male 22.03±16.41 mm, female 20.60±14.56 mm). Minimal thickness of the myocardial bridge was 1 mm, maximal 8 mm and the average thickness was 3.744±1.48 mm without significant gender differences (male 3.72±1.44 mm, females 3.90±1.79 mm).

The analyses of the variants showed that in the lower half of the front descendant branch of the left coronary branch, significantly longer myocardial bridges were found – 34.5 to 20.4 mm (F=5.85, df=1, p=0.0180); the thickness of myocardial bridges in relation to their position, while somewhat thinner myocardial bridges were found in the lower part of the front descending branch of the artery than in the upper half (3.62 to 3.75) without statistically significant differences (F=0.06, df=1, p=0.8128).

Localization of myocardial bridge does not depend on the type of heart vascularization (left 44%, right 28% and mixed 24%, χ^2=17.3200, df=15, p=0.3001).

The border limit for the heart hypertrophy was the heart mass of 300 g: the heart mass up to 300 g was found in 12.82% and 10%, over in 87.18% – 68 cases.

In relation to the mass of the heart and the length of the myocardial bridge, marginal statistic significance was found (Pearson's correlation quotient r=0.2, p=0.0791).

Our results show that regardless of the existence of the myocardial bridge in 70% of cases, there was no evidence of a coronary atherosclerotic disease on the descending branch of the left coronary artery. However, some coronary atherosclerotic diseases were found in 30% (23 cases) and were exclusively located above the myocardial bridge. In older individuals (aged over 60), if there was a myocardial bridge, the frequency of atherosclerotic diseases was over 80%.

Presence of the myocardial bridge was established in the analyzed sample of 12.50% of natural deaths (26 out of 208) (Table 1).

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Table 1. Manner of death and the presence of myocardial bridge

Myocardial bridge	Natural		Violent		Total	
	N	%	N	%	N	%
With	26	12.5	52	6.8	78	8.0
Without	182	87.5	715	93.2	897	92.0
Total	208	100.0	767	100.0	975	100.0

Out of all deaths, violent deaths occurred in 127 cases (61.05%) and in 17 of these cases (13.38%) the presence of the myocardial bridge was established. However, in 81 cases of natural deaths where the cause of death was not a heart disease, the myocardial bridge was represented in 9 cases (11.11%) whereas there were no statistically significant differences between the representation of the myocardial bridge in violent deaths and other causes of natural deaths (χ^2=1.134, df=1, p=0.287).

Statistical analysis of the group with a myocardial bridge did not show any significant influence of the myocardial bridge thickness, either in the frequency of arteriosclerosis in the descending artery (Spearman -0.124, p=0.280) or in a more frequent occurrence of natural cardiac death (Spearman +0.108, p=0.346).

DISCUSSION

Analyzing 1000 post-mortem cases of people who died of natural causes, Di Maio found that 60.9% deaths were caused by a sudden heart failure [9]. Congenital anomalies and variations of coronary blood vessels, amongst which is the embedded coronary, might be the cause of acute ischemic lesion of the myocardium and a sudden death in young people [10]. Depending on the study, whether it is autopsy or a clinical study – the frequency of myocardial bridges ranges from 0.5% to 16% in angiographic studies, up to almost 86% in autopsy studies; in our geographical area a post-mortem pathological study resulted in the frequency of 4.8% [11-16]. The frequency of myocardial bridges in our sample of 8.00% was more in accordance with angiographic findings than with the so far published results based on autopsy studies. It is realistic to expect a greater frequency of a myocardial bridge in clinical studies, because the examined patients already have heart problems. According to this, a recently published high frequency of cases in post-mortem studies can be explained by the choice of deaths caused by heart failures. Significantly higher percentage of myocardial bridges in the group where natural deaths occurred, rather than in the group of violent deaths, showed that the myocardial bridge could be a predisposing factor for the occurrence of a sudden heart failure and death. This is especially relevant for men where a myocardial bridge has been significantly more often noticed (9.35% males) than in women (4.06%).

Myocardial bridges appear on the average 33.8 mm below the beginning of the left coronary artery, while 82.6% of myocardial bridges are localized in the middle third [2, 17] – our study agree with this. In our sample over 13% cases show the so-called 'tandem myocardial bridge'- longer than 35 mm that affects both, the top and the middle segments, or the middle and the lower segments of the LAD [2].

The length of myocardial bridges varies from 5 to 50.2 mm [1, 2, 18]. Our study shows that the average length of a myocardial bridge is 22.03, closest to the results of Solte (22.5 mm) [17].

Analyzing the data considering the thickness of myocardial bridges, clinical researches show that the thickness varies from 1.0 to 3.8 mm [2, 17, 18]. Measures on the post-mortem material are from 0.131 to 12 mm [19]. The average thickness of a myocardial bridge of 3.75 mm that was found in our research is in complete agreement with the previous autopsy studies. Both the thickness and the length of the myocardial bridge directly affect the magnitude of the systolic compression of the submerging coronary artery. In publications it is found that the thickness grows with the length of a myocardial bridge [1]. Analyzing the relationship between the thickness and the length of myocardial bridges, we found that with the length the thickness of the myocardial bridge increases with marginally positive correlation (p=0.0518). It is interesting that in our sample the thickness of the myocardial bridge does not affect either the more frequent occurrence of proximal atherosclerosis or the more frequent occurrence of a sudden cardiac death.

Our results agree that the occurrence of ischemia has been identified in patients with a myocardial bridge in association with a hypertrophy of the heart [20, 21]. Namely, from 78 established myocardial bridges only in 13% of cases the hypertrophy of the myocardium did not exist. Such results show that the presence of the myocardial bridge may be one of predispositions for myocardial hypertrophy.

Karahan et al. [22] point out the connection between hypertrophy of the left chamber and the existence of a myocardial bridge. Our own results show that the average thickness of the left chamber in the group with a myocardial bridge is 15.286±1.783 mm, whilst in the group without the myocardial bridge it is 16.295±2.146 mm. At first sight, these results are in disagreement with the published ones, but it should be kept in mind that our sample incorporated individuals who died through violence, predominantly young and middle-aged people who did not have enough time to develop a significant hypertrophy of the left chamber. Also, there is a positive correlation between the frequency of a myocardial bridge and the mass of the heart.

One of possible mechanisms by which myocardial bridges cause ischemic diseases of the heart is increased tendency for arteriosclerosis in the segment proximal to the myocardial bridge due to a 'shear stress' effect caused by hemodynamic exchanges of the blood flow in the coronary artery and the dysfunction of the endothelium, whilst the endothelium below the myocardial bridge is structurally more resistant to atherosclerosis [2, 23]. Ishikawa et al. [1] have established a protective effect of the myocardial bridge in relation to arteriosclerosis; the greater the thickness and the length of the myocardial bridge, the rarer

is the occurrence of arteriosclerosis on the over-bridging area. This is explained by a difference in the contractile power of the myocardial bridge during the systole; this is in agreement with the previous angiographic studies showing myocardial bridges on the left descendent branch together with hypertrophy of the heart, all leading to a much greater compression of the blood vessel and reduction of the blood flow [1, 24]. We found that arteriosclerosis is much more frequent if proximal to the myocardial bridge.

CONCLUSION

It is apparent that in individuals with a myocardial bridge there is no pathological substrate (length and thickness of the myocardial bridge, arteriosclerosis, heart hypertrophy, etc.) on which the course and final outcome of this anatomical entity could be predicted.

From the forensic aspect, the most important fact is that the existence of the myocardial bridge, considered separately, is not a predominant factor for a sudden cardiac death, but a sufficient one when combined with the clinical history or ischemia confirmed by ECG and followed by the microscopic diagnosis of infarct in the dependent area of vascularization.

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Миокардни мостови – проспективна форензичка аутопсијска студија

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КРАТАК САДРЖАЈ

Увод„Понирућа коронарна артерија" је појам који се односи на случај када коронарна артерија – иначе локализована субепикардно – понире у миокард и поново се појављује субепикардно, после кратког пута кроз мишић, при чему се мишић изнад ње назива „миокардни мост".

Циљ рада Истраживали смо учесталост понирућe десцендентне гране леве коронарне артерије у аутопсијском материјалу имајући у виду да је она најважнија у исхрани срчаног мишића, да најчешће понире у срчани мишић и да је врло значајна и с клиничког аспекта.

Методе рада Урађена је проспективна аутопсијска студија 975 случајева природних (21,33%) и насилних смрти (78,67%). Узорак је обухватио 74,56% особа мушког и 25,44% женског пола. Ради откривања миокардног моста и анализе његових особености, нисходна грана леве коронарне артерије отварана је уздужним и попречним обдукционим резовима.

Резултати Миокардни мост је утврђен у 78 случајева (8,00%), чешће код мушкараца (9,35%) него код жена (4,03%). Просечна дужина миокардног моста била је 21,85±16,10 *mm*, а дебљина 3,744±1,48 *mm*. Најчешћа локализација миокардног моста била је у пределу проксималне половине десцендентне гране леве коронарне артерије (89,74%), а атеросклеротске промене су најчешће установљене усходно од миокардног моста. Миокардни мост је постојао у 12,50% случајева природних смрти, односно у 13,38% случајева тзв. напрасних срчаних смрти.

Закључак Постојање миокардног моста није предоминантни чинилац за појаву напрасне срчане смрти, али је његово постојање фактор ризика за њен настанак.

Кључне речи: миокардни мост; форензичка аутопсијска студија; порекло смрти

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