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Original research article

Myocardial bridges: An Ultra Structural Study

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Abstract

Introduction: The heart is supplied by right and left coronary arteries. Coronary arteries are physiological end arteries but not anatomical. Coronary arteries are normally epicardial in position except in some cases where a segment of coronary artery is overlapped by a bunch of cardiac muscle fibres. This pattern of arrangement of cardiac fibres over a segment of coronary artery is known as myocardial bridging. Presence of myocardial bridges causes atherosclerotic changes in the pre bridged segment and bridged segment is spared from atherosclerosis.

Material and Methods: A total number of 200 heart specimens were observed for this study. A fresh non MLC specimens were included for scanning electron microscopic study.

Results: Pre bridged segment of coronary vessel presented the thick tunica intima with atherosclerotic formation. The Polygonal epithelial cells were seen on the surface. In tunica intima plenty of elastic fibres were observed. Tunica media presented a clear muscular component with loose connective. Our present results are correlating with previous histology studies.

Conclusion: Myocardial bridges are not an uncommom condition. Many histological studies are available in the review. In our study also we found the same conclusions as histological studies. The pre bridged segment is more prone for atherosclerotic changed than the bridged segment of coronary artery.

Keywords: Myocardial bridges (MB), Intra mural, Atherosclerosis and Coronary arteries

Introduction

The heart is supplied by right and left coronary arteries. Coronary arteries are physiological end arteries but not anatomical [1, 2]. Coronary arteries are normally epicardial in position except in some cases where a segment of coronary artery is overlapped by a bunch of cardiac muscle fibres. This pattern of arrangement of cardiac fibres over a segment of coronary artery is known as myocardial bridging. The segment of coronary artery with intramural course is known as tunneled artery or intramural artery. Myocardial bridge (MB) is not an uncommon condition and is usually clinically silent. MBs are of incidental observation either during autopsy or during diagnostic coronary angiography [3].

MBs have an embryological origin and there is no gender difference regarding their incidence. Myocardial bridge is generally considered to be a vascular heart variation and it can cause intermittent reduction of arterial lumen, with a possible ischemic effect. The incidence of myocardial bridges varies from one population to other [3].

Myocardial bridges were first reported in 1737 by Rayman [4]. The first post-mortem examination of MBs was performed by Geiringer in 1951 [5]. The first radiological description of MB was by Portman & Ingrid in 1960 [6].

Myocardial bridges are most commonly localized on the middle segment of left anterior descending artery (LAD). Coronary atherosclerosis in association with myocardial bridging was primarily studied in the LAD. The segment proximal to the bridge frequently shows atherosclerotic plaque formation, although the tunneled segment is typically spared. Hemodynamic forces explain atherosclerotic plaque formation at the entrance to the tunneled segment. The non-significant stenosis proximal to the bridge or systolic compression of the tunneled segment alone explains severe ischemia and associated symptoms [7]. This is supported by the studies at the cellular and ultra-structural level [8, 9].

In the last century many investigators reported about myocardial bridges. Though many authors gave their opinion, still it is a controversial topic. In the literature the conclusions reported were based on either autopsy or angiography studies. There were many studies available in the literature concern with histological studies of myocardial bridges but a very few studies were observed concern with ultra structure of myocardial bridges.

Methods

A total of 200 human cadaveric heart specimens of both sexes available in the department of Anatomy

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and Forensic medicine were utilized for this study. Fresh NON- MLC autopsy specimens were collected with the informed consent from the relatives of deceased. Heart specimens were preserved in 10% formalin for 2-3 days.

After careful dissection of epicardial fat along with the course of coronary arteries, number of myocardial bridges (MBs), their location in relation to the branches of coronary artery and their direction were recorded. Fresh autopsy specimens were utilized for Scanning Electron Microscope (SEM) analysis. 2-3mm thick of pre bridged, bridged and post bridged segments of coronary arteries were obtained for SEM analysis. We have chosen a protocol retrieved from the University of Alabama (UA) that effectively defines a general schedule for preparing animal tissue for SEM analysis [10] (protocol-1).

A Scanning Electron Microscope (SEM) was used, specifically the ZEISS E10 MA-15(OXFORD INCA PENTA FET X3 model 8100), to image the coronary blood vessel tissue. After dehydration and gold plating the specimen was fixed to the SEM sample stage using double sided tape. Proper height adjustment was made to make sure the stage and sample were cleared the ceiling of the sample feed and was high enough for the SEM to bring an image of the vessel surface into focus. Several sets of images were taken from each sample at the magnification of 500x. For observing endothelial changes and cardiac muscle fibres a magnification of 1000x was used.

Ethics

The present work has been undertaken with the permission of institutional ethical and research committee of S.V. Medical College, Tirupati, Andhra Pradesh, India.

Results

Scanning electron microscopic appearance of coronary vessel and cardiac muscle fibres may add more information regarding the ultra structure. The SEM appearance of cardiac muscles is shown in the fig.1. Branching and anastomosing pattern of cardiac muscle fibres, with a clear bulged nucleus was observed.

Pre bridged segment of coronary vessel presented the thick tunica intima with atherosclerotic formation. The Polygonal epithelial cells were seen on the surface. In tunica intima plenty of elastic fibres were observed. Tunica media presented a clear muscular component with loose connective (fig.2).

Bridged coronary vessel was separated from bridged muscle fibres by perivascular space with connective tissue (fig.3). Spindle shaped epithelial cells were observed in bridged coronary vessel (fig.4). In post bridged the epithelium was of mixture shape of polygonal and spindle shapes. Thin tunica intima and adventitia with loose connective tissue and blood vessels (fig.5) were observed.

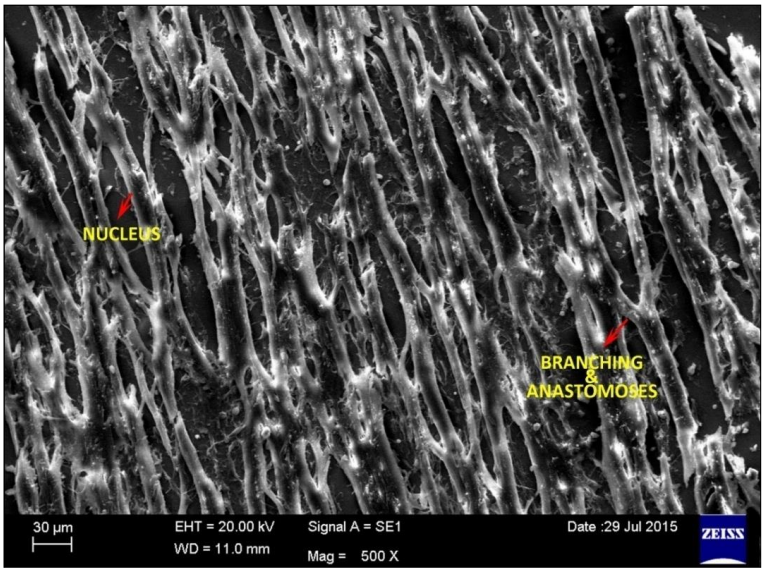

Fig 1: Cardiac muscle – Bulged nucleus, branching & anastomosis (500x magnification

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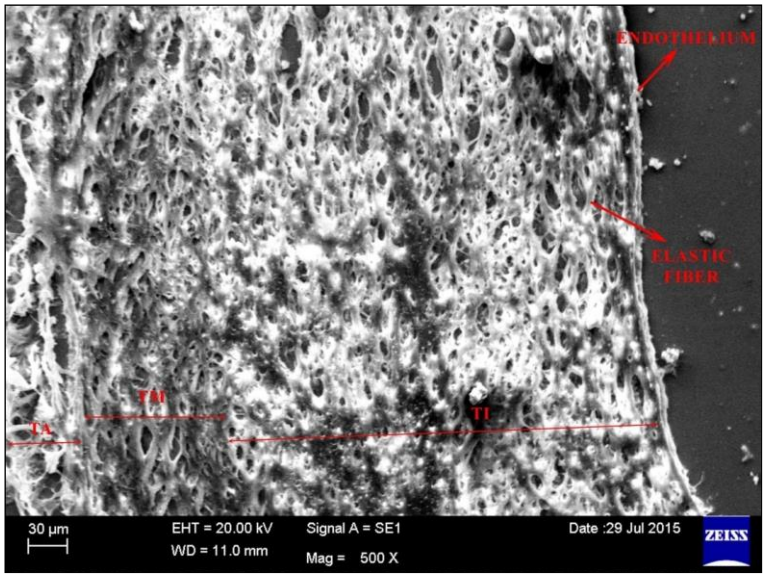

Fig 2: Pre bridged coronary vessel – Thicker TI with atherosclerosis & prominent elastic fibers (500x magnifications)

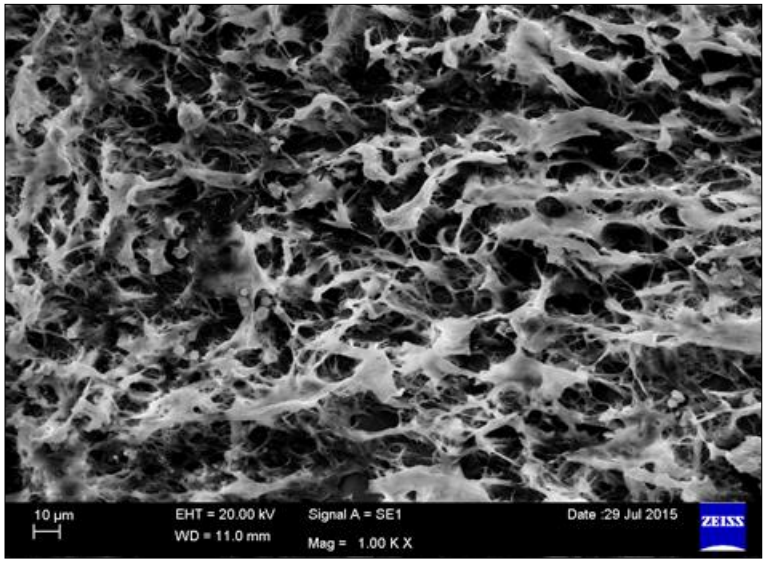

Fig 3: Perivascular cushion of connective tissue and adipose cells (1000x magnification)

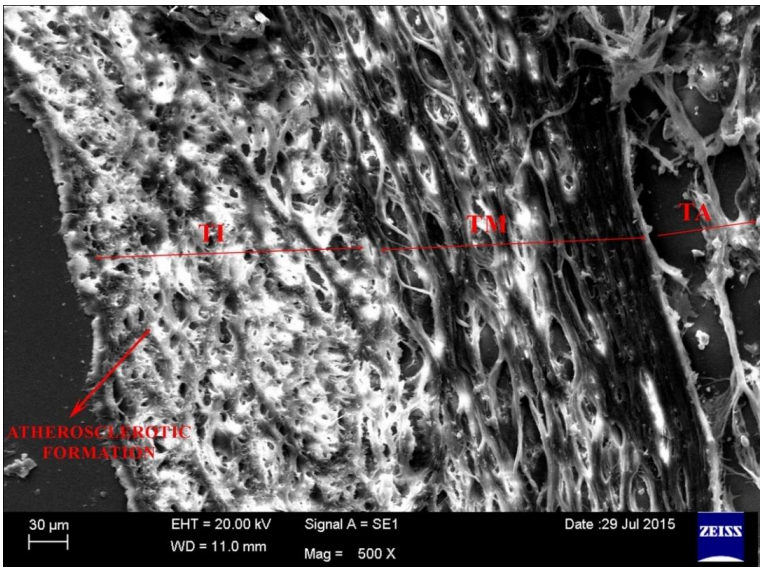

Fig 4: Bridged coronary vessel – Thin tunica intima with atherosclerosis &media (500x magnification)

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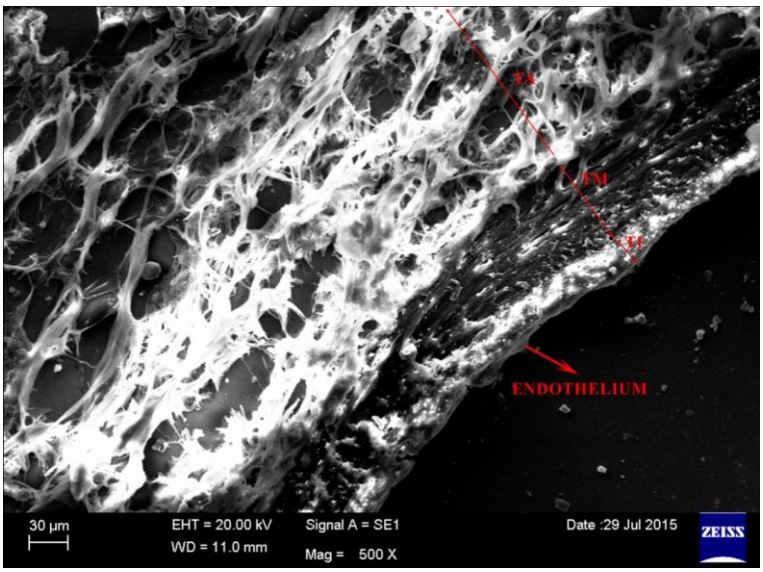

Fig 5: Post bridged coronary vessel- clear endothelium and prominent adventitia (500x magnification)

Discussion

The most common cause of death in affluent society across the world is ischemic heart disease (IHD) which results from the occlusion of coronary arteries. Major course of coronary arteries are sub epicardial and the vessels generally dip into the myocardium at their termination. Occasionally a segment of coronary artery or its branch runs an intramural course underneath the bridge of myocardium.

Morphology of myocardial bridge plays an important role in pathophysiology of different cardiac diseases.

Ultra structural studies revealed that secretary type of smooth muscle cells proliferate and are responsible for the atherosclerosis progression. But the tunica intima of bridged coronary vessel always contains contractile type of smooth muscles which are against to atherosclerosis formation [8]. The results of present study on histological and ultra structural appearance are also correlating with that reported in the literature [8, 11, 12, 13]. In addition in the present study in majority of the specimens we observed more thickened tunica intima in the proximal segment of bridged coronary vessel when compared with bridged and post bridged coronary vessel which is in agreement with that reported in literature [8, 11, 12, 13, 15]. Out of 9 specimens in the present study we observed atherosclerotic formation in bridged coronary vessel in one specimen. In the literature Tej *et al.* [16] reported a case of atherosclerotic formation in bridged segment in their case report.

Normally the atherosclerotic changes progress from tunica intima to media of any vessel but Julius Ogeng'o *et al.* [17] reported atherosclerotic changes in tunica adventitia. They stated that without changes in tunica intima and media there are chances of atherosclerosis progression from tunica adventitia. They also reported thicker adventitia in atherosclerotic vessel. In our study we did not observe any atherosclerotic changes in tunica adventitia of coronary vessel of pre bridged coronary vessel but thickness of adventitia was more in pre bridged segment when compared with bridged and post bridged segments in this region of South India population.

The SEM reveals that the endothelial cells proximal to MB were polygonal and flat in shape, but those under the MB becomes spindle shaped, engorged and aligned in the direction of blood flow. These changes of endothelial cell shapes and alignment between the two segments indicates that the intimal surface of the coronary vessel under the MB is subjected for high shear stress, resulting in reduced ability to atherosclerotic changes. In our study also we observed the epithelial changes in bridged coronary vessel and components in coronary vessel wall.

Conclusion

Results of present study on ultra structure suggest that presence of myocardial bridge protects the bridged coronary vessel and the pre bridged segment is more prone for atherosclerosis. The mechanism of protection is that presence of MBs greatly alters the distribution of physical pressure against the vascular wall which in turn influences the extent of atherosclerosis formation and intimal thickening.

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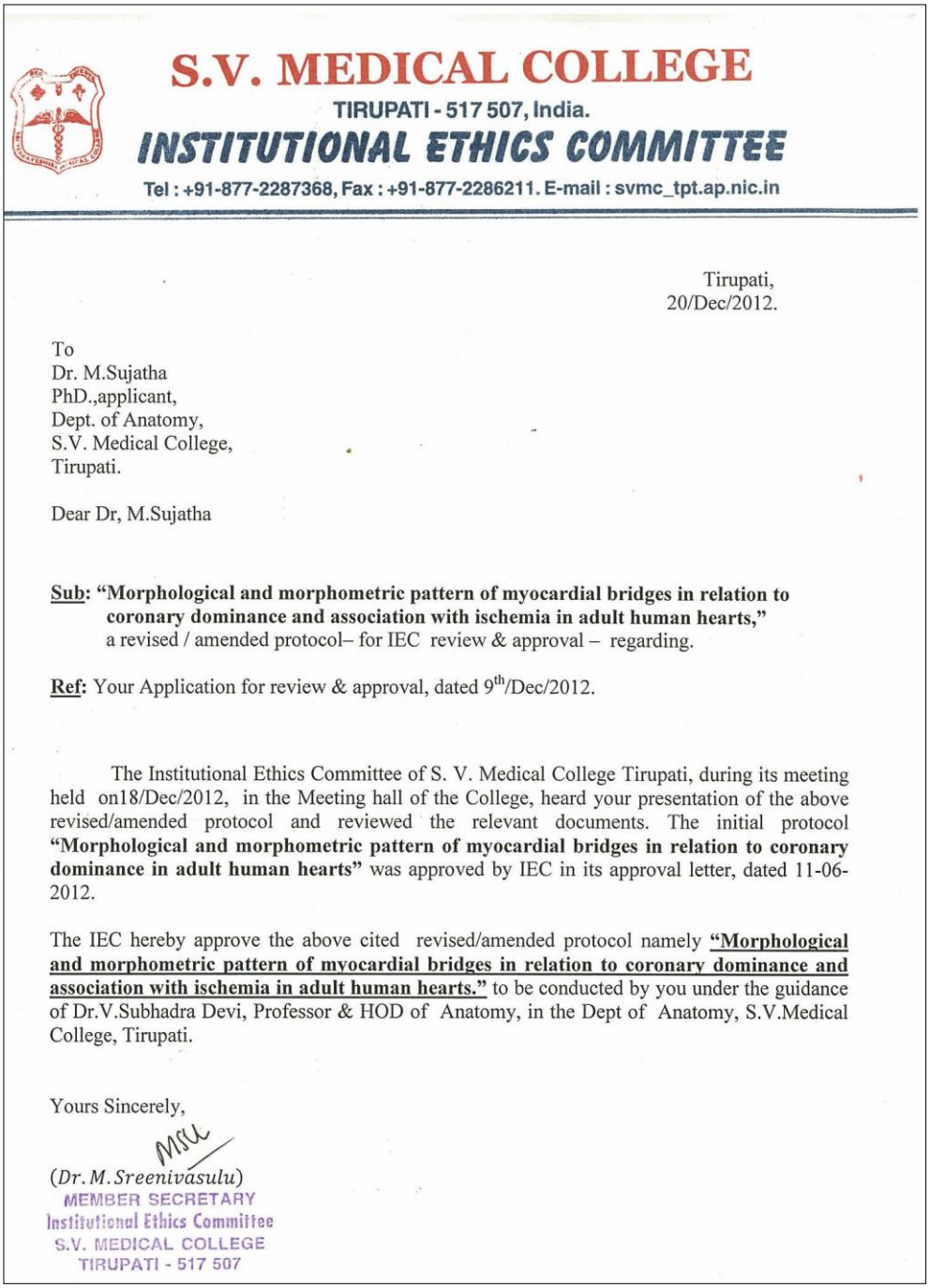

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Tirupati,
20/Dec/2012.

To
Dr. M.Sujatha
PhD.,applicant,
Dept. of Anatomy,
S.V. Medical College,
Tirupati.

Dear Dr, M.Sujatha

Sub: "Morphological and morphometric pattern of myocardial bridges in relation to coronary dominance and association with ischemia in adult human hearts," a revised / amended protocol– for IEC review & approval – regarding.

Ref: Your Application for review & approval, dated 9th/Dec/2012.

The Institutional Ethics Committee of S. V. Medical College Tirupati, during its meeting held on18/Dec/2012, in the Meeting hall of the College, heard your presentation of the above revised/amended protocol and reviewed the relevant documents. The initial protocol **"Morphological and morphometric pattern of myocardial bridges in relation to coronary dominance in adult human hearts"** was approved by IEC in its approval letter, dated 11-06-2012.

The IEC hereby approve the above cited revised/amended protocol namely **"Morphological and morphometric pattern of myocardial bridges in relation to coronary dominance and association with ischemia in adult human hearts."** to be conducted by you under the guidance of Dr.V.Subhadra Devi, Professor & HOD of Anatomy, in the Dept of Anatomy, S.V.Medical College, Tirupati.

Yours Sincerely,

(Dr. M. Sreenivasulu)
MEMBER SECRETARY
Institutional Ethics Committee
S.V. MEDICAL COLLEGE
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Protocol for Tissue preparation procedure for scanning electron microscope

1. Fix the tissue in 2.5% glutaraldehyde (primary fixative) for 1-2 hours.
2. Wash the tissue for 10-20 minutes under running distilled water. Repeat the wash for 3-5 times if required.
3. Fix the tissue in 1-4% of osmic tetraoxide (secondary fixative) for 1-2 hours.
4. Wash the tissue for 10-20 minutes under running distilled water. Repeat the wash for 3-5 times if required.
5. Dehydrate the tissue in ascending grades of ethanol (25%, 50%, 75%, 95% and 100%).
6. Dry the specimen in room temperature.
7. Mount the specimen on specimen stub with silver paste.
8. Coat the specimen with gold or platinum plating.
9. Store the stub in desicator.
10. Subject the tissue for SEM analysis.

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