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Cellular Interaction around Capillaries in Different Parts of Heart at Myocardial Infarction

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ABSTRACT

Background: The problem of high mortality from myocardial infarction (MI) is very actual all over the world in spite of the progress in diagnostic and treatment. The great amount of investigations is directed to cell therapy, which is focused on the correction of cell populations in hurried and intact zones to stimulate reparation. In this work the investigation has been done according to the study of perivascular communicative systems.

Materials and methods: 73 hearts of dead people from MI were investigated. According to the morphology and multiplicity, they were divided into 6 groups: acute (AMI) and recurrent (RMI) MI with prescription 1-2 days (AMI-1, RMI-1); 3-5 days (AMI-2, RMI-2); more than 5 days (AMI-3, RMY-3). During the autopsy samples of cardiac muscle 1 cm^3 in capacity were cut from the centre of necrotic zone (LV-1), demarcation zone (LV-2). We accepted the center of interventricular septum (IS) as intact zone . The material was microscopically analyzed with Hematoxylin and Eosin and morphometric accounting of cells of stroma was done. For statistical treatment non parametric methods were used: U-test and Spearmen rank correlation coefficient. Probability values <0.05 were considered significant.

Results: Quantitative differences were the following: prevalence of hematogenic cells for AMI and histogenic cells for RMI. The greatest amount of differences were found in AMI-3 and RMI-3. Quantitative differences were more particular for macrophages (Mph), fibroblasts (Fb) and polymorphonuclear leucocytes (Pnl) in LV-1 - LV-2 and LV-1 - IS. Significant differences were mostly for groups AMI- 2-RMY-2. Significant differences LV-2 and IS were rare and were related to Fb, fibrocytes (Fc) and lymphocytes (Lf). Only Lf of LV-1 had a positive correlation with Lf in LV-2 and IS in all groups. In all groups mostly histiogenic cell elements had a positive correlation (Lf, Fb, Fc).

Conclusions: Differences of quantitative rates for AMI and RMI were concentrated in demarcation zone. There was a domination of the hematogenic cells elements for AMI and histogenic for RMI. The most significant differences were for AMI-2 and RMI-2. There was not a great number of correlation, probably because of a short-run process.

Keywords: Myocardial infarction, cell populations, morphometry

Introduction

In spite of significant progress in diagnosis and treatment of myocardial infarction (MI), this pathology is leading among other nosologies in the structure of mortality of adults. According to the data of WHO in 2002 this rate all around the world, including developing countries was 12.6% and it is the highest rate as compared with another nosologies [1]. A big attention is now paid to cell therapy [6], its mechanisms may be uncovered due to the study of cell populations in necrotic zone, demarcation zone and intact zone [8]. Appearance and interaction of different cells in injured zone [3] are aimed to activation of angiogenesis which stimulates repair rand that is studied as therapeutic agent at MI [4, 7].

The study of perivascullar communicative systems [2] was worked out in Smolensk Region Pathological Institute and was successfully applied to neoplastic processes. In this work it was applied to another pathological process – necrosis. Studying of microenvironment around microcirculation stream vessels in different parts of cardiac muscle in different terms of MI may have some importance for researching pathogenesis and outcomes of MI.

Aims

- Establish differences in formation of cell populations around capillaries in acute myocardial infarction (AMI) and recurrent myocardial infarction (RMI).
- Search out relations in qualitative and quantitative characteristics of infiltration in necrotic zone, demarcation zone and intact zone.
- Search out differences in cell populations of the zones according to different terms of MI.

Materials and methods

Hearts of 73 dead people with diagnosis MI were studied. Only samples with MI of free wall of left ventricle were taken. According to the morphology all samples were divided into 6 groups:

- AMI with prescription of 1-2 days- 19 cases (group AMI-1)
- RMI with prescription of 1-2 days- 17 cases (group RMI-1)
- AMI with prescription of 3-5 days- 10 cases (group AMI-2)
- RMI with prescription of 3-5 days- 5 cases (group RMI-2)
- AMI with prescription more than 5 days- 8 cases (group AMI-3)
- RMI with prescription more than 5 days- 14 cases (group RMI-3)

During the autopsy samples of cardiac muscle 1 cm^3 in capacity were cut from the centre of necrotic zone (LV-1) and demarcation zone (LV-2). We accepted the center of interventricular septum (IS) as intact zone. The material was analyzed in microscopy with the help of Hematoxylin and Eosin and morphometric studies were done. Histological sections were studied in 10 different fields of view with a magnification of x400. Every time the capillaries were in the centre of the field of view and they did not overlap. Stroma cells such as lymphocytes (Lf), macrophages

(Mph), fibroblasts (Fb), fibrocytes (Fc), plasma cells (Pc) and polymorphonuclear leucocytes (Pnl) were counted. For statistical treatment non parametric methods were used: U-test and Spearmen rank correlation coefficient. Probability values <0.05 were considered significant. Results were got with such software as Microsoft Excel and Stat Plus 2009 Professional.

Results

The cases were divided into groups according to the morphology (Table 1). For MI 1-2 days we took the cases in which we found fields of unnucleate cardiomyocites with readable outlines, an edematic stroma, stasis of leukocytes or a moderate leukocytic infiltration. For MY 3-5 days long structure less masses of cardiomyocites with a severe leukocytic infiltration were taken. A lot of Pnl were destroyed. In cases with prescription of MI more than 5 days we found granulation tissue with new formed vessels and macrophage-lymphocyte infiltration [5, 8]. Death of the patients took place in some hours to 17 days.

1. Quantitative comparison of perivascular infiltrate in AMI and RMI

1.1. In comparing of quantitative rates (comparison on medians) of cells infiltrates in necrotic zone (LV-1) in AMI and RMI the following relationships were determined. Differences with high measures of significance ($p<0.01$) were found for Fc in groups AMI-1 and RMI -1: the amount of Fc is higher in RMI. The amount of Pnl is higher in AMI-2 than in RMI-2. The amount of Mf is higher in RMI-3 than in AMI-3 ($p<0.05$).

1.2. In the similar comparison of demarcation zones we found out that the amount of Fb in RMI-1($p<0.01$), RMI-2 ($p<0.05$), RMI ($p<0.05$) was higher than in AMI of the same prescription. The amount of Lf was higher in AMI -2 than in RMI-2 ($p<0.001$) and in AMI-3 than in RMI ($p<0.05$). There was much more Pnl in AMI-1 than in RMI ($p<0.05$).

1.3. During the investigations of IS statistically reliable differences ($p<0.01$) were only in pair of AMI-3 and RMY-3 and were covered with Pnl.

2. Significant differences between cells populations in LV-1, LV-2 and IS

2.1 AMI-1: the amount of Mf and Pnl is significantly higher in LV-1 than LV-2 ($p<0.05$ and $p<0.01$ respectively). The amount of Fb is higher in LV-2 than in IS ($p<0.05$).

2.2 RMY-1: the amount of Pnl in LV-1 was higher than Pnl in LV-2 ($p<0.01$) and there was more Pnl in LV-2 than Pnl in IS ($p<0.01$).

2.3 AMI-2: there was statistically reliable increase of amount of Lf in LV-1 against LV-2 ($p<0.05$). Also there was a great number of significant differences LV-1 as compared with IS (amount of all cell populations in LV-1 are more than IS): Lf ($p<0.01$), Mf ($p<0.01$), Fb ($p<0.001$), Fc ($p<0.05$). There was less of Fb in LV-2 than in IS ($p<0.01$), but there was more of Fc ($p<0.05$).

2.4 RMI-2: the amount of Lf ($p<0.01$), Mf ($p<0.01$), Pnl ($p<0.001$) was more in LV-1 than in LV-2. Also there was more of Mf ($p<0.05$), Fb ($p<0.01$) and Pnl ($p<0.01$) in zone LV-1 as compared with IS.

2.5 AMI-3: quantity of Pnl was more in LV-1 than LV-2($p<0.05$). Also there was more of Mf and Fb in LV-1 than LV-2 ($p<0.001$ for both cell populations). In IS the quantity of Fb was higher than in LV-2 ($p<0.001$).

2.6 RMI-3: there was more of Pnl in LV-1 than in LV-2 ($p<0.05$). The quantity of Lf was higher in IS than in LV-2 ($p<0.05$).

Thus, the most frequent quantitative distinctions are observed between necrotic zone and demarcation zone and also between necrotic zone and intact zone. Pnl, Mf, Fb are the most frequently varied cell populations, that is responsible for inflammation and damage healing. The most often significant differences are in the groups AMI-2 and RMI-2. Significant differences between LV-2 and IS are much more rare and connected with Fb, Fc and Lf- cell populations are responsible mainly with reparation. Insignificant distinctions of cell populations between IS and LV-2 may be caused by generality of processes which take place in this zones during the formation of necrosis foci.

3. Correlation dependence between cell elements in different parts of the heart at myocardial infarction which was revealed with Spearmen rank correlation coefficient ($p<0.05$)

After the analysis of the scheme, we can make a conclusion, that only Lf from necrotic zones have a positive correlation with demarcation and intact zone of all groups of cases. In all groups significant positive correlation has mostly histogenic cell populations (Fb, Fc, Mf).

Conclusions

Here is a list of the conclusions drawn from this research:

1. The greatest amount of significant differences for quantitative rate of cells populations around capillaries at acute and recurrent myocardial infarction was revealed for demarcation zone, as opposite to necrotic and intact zone where it was minimal.
2. Foregoing differences are coming to the prevalence of hematogenic cell populations at acute myocardial infarction but to the prevalence of histogenic cell populations at recurrent myocardial infarction.
3. The greatest amount of significant differences for quantitative rate of cell populations were revealed at acute and recurrent myocardial infarction of prescription 3-5 days. It may point to the greatest activity of inflammation and reparation processes in this period.
4. Significant differences between demarcation and intact zone were rare and were associated with fibroblasts, fibrocytes and lymphocytes – i.e. histogenic cell populations chargeable for reparation.
5. Low differences between cell populations in demarcation and intact zone may be explained by the uniformity of these zones during necrotic zone formation.

Absence of great amount of the correlation between cell population of different zones and absence of communication systems may be explained by short-time process. Probably the absence of blood flow in necrotic zone blocks the penetration of cells and the formation of strong associations and interactions between them.

Conflict of Interest: None declared.

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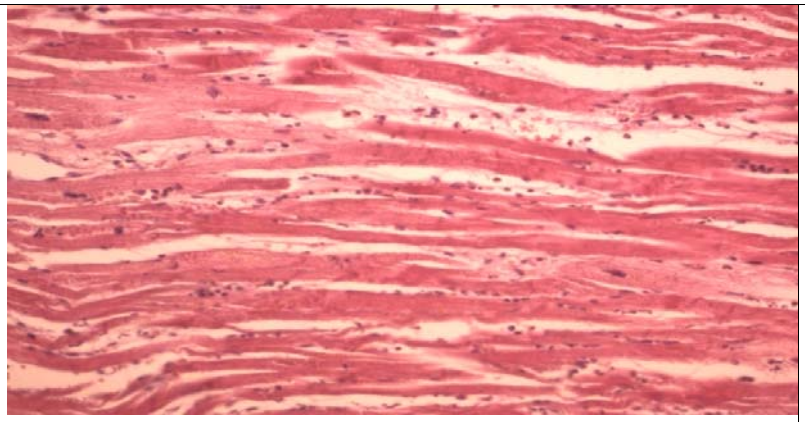
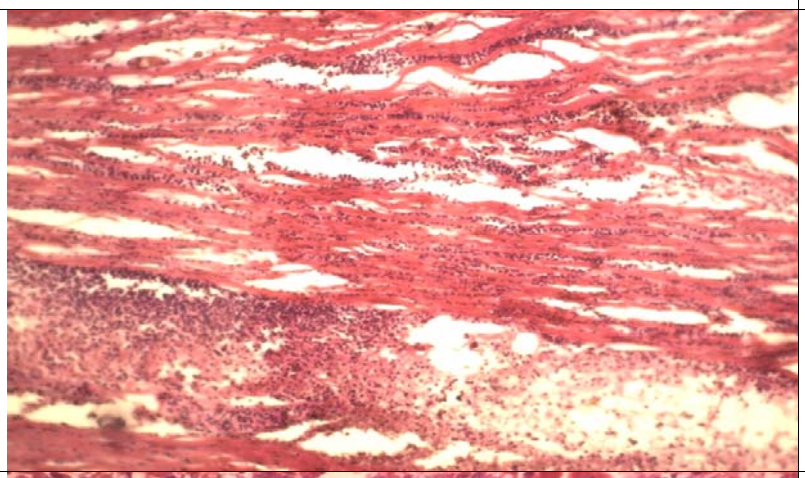
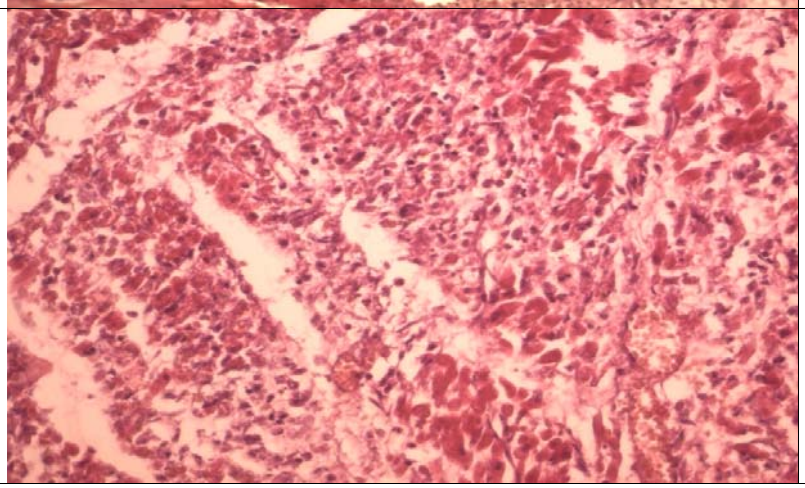
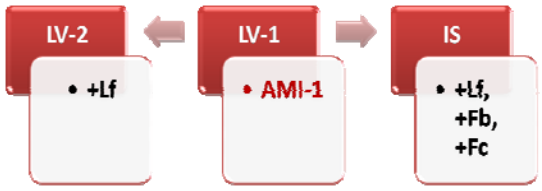
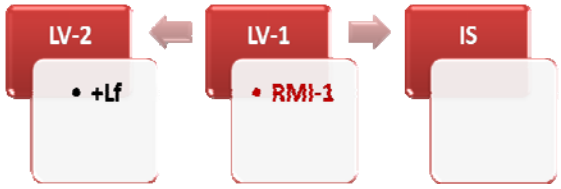
Table 1: Morphology of different terms of MI

		***MI 1-2 days***
		***MI 3-5 days***
		***MI more than 5 days***

Prescription of MI	AMI	RMI
1-2 days		
3-5 days		
More than 5 days