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Diagnosis of myocardial infarction based on lectin-induced erythrocyte agglutination - a feasibility study

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Introduction
Myocardial infarction (MI) caused by arteriosclerosis is an acute life-threatening disease and has a high incidence worldwide. Fast and precise diagnosis of coronary heart diseases (CHD) could assure proper therapies and drug-treatment. The aim of this study was to evaluate the feasibility of lectin-carbohydrate binding-induced red blood cell (RBC) agglutination for the fast and precise diagnosis of MI. We hypothesize that pathological changes induce modification of the composition of carbohydrates on the RBC membrane. Occurrence and distribution of carbohydrates on RBC membranes may provide evidence for MI.

After optimization of sample preparation and measurement conditions, five different lectins (Ricinus communis agglutinin (RCA), Phaseolus vulgaris erythroxagglutinin (PHA), Datura stramonium agglutinin (DSA), Artocarpus scindapsus agglutinin (ArA), and Triticum aestivum agglutinin (TA)) were tested to investigate the agglutination characteristics of patients with MI or angina pectoris (AP) and healthy volunteers (HV) as control group. RBC agglutination was analyzed by light absorbance of a stirred RBC suspension in a broad range in green and red light in an agglutimeter (amtec) for 15 min after lectin addition. Mean cell count in aggregates was estimated from light absorbance by mathematical model.

Buffers used during preparation of the sample and anticoagulants can have an influence on the agglutination process. We found that buffers containing Ca²⁺ led to a stronger and faster agglutination. Moreover, thorough mixing of the lectin-blood-buffer suspension with an optimally shaped stirrer is essential for good agglutination.

Results for CHD-diagnosis

Each lectin tested leads to a stronger RBC agglutination in CHD-patients compared to HV. The lectin RCA provoked the biggest aggregates, i.e. aggregates with the highest RBC count. It is supposed that RCA has the strongest binding affinity to the carbohydrates on the RBC membrane. By using the lectin PHA, the highest difference between agglutination of MI-bloodsamples and healthy ones is observable.

Discussion and conclusion:
It is possible to differentiate between patients with MI and AP based on PHA-induced RBC-agglutination. Each lectin tested leads to a stronger RBC agglutination in CHD-patients compared to HV. The lectin RCA provoked the biggest aggregates, i.e. aggregates with the highest RBC count. It is supposed that RCA has the strongest binding affinity to the carbohydrates on the RBC membrane. By using the lectin PHA, the highest difference between agglutination of MI-bloodsamples and healthy ones is observable. The RBC-agglutination assay could be a valuable and fast diagnostic test for myocardial infarction.

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Methodical requirements - optimal analysis of the agglutination process requires special conditions

Buffers used during preparation of the sample and anticoagulants can have an influence on the agglutination process. We found that buffers containing Ca²⁺ led to a stronger and faster agglutination. Moreover, thorough mixing of the lectin-blood-buffer suspension with an optimally shaped stirrer is essential for good agglutination.
Abstract

DIAGNOSIS OF MYOCARDIAL INFARCTION BASED ON LECTIN-INDUCED ERYTHROCYTE AGGLUTINATION - A FEASIBILITY STUDY

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Background: Myocardial infarction (MI) caused by arteriosclerosis is an acute life-threatening disease and has a high incidence worldwide. Aim of this study was to evaluate the feasibility of lectin-carbohydrate binding-induced red blood cell (RBC) agglutination for the fast and precise diagnosis of MI. Methods: In this study, five different lectins (Ricinus communis agglutinin (RCA), Phaseolus vulgaris erythroagglutinin (PHA), Datura stramonium agglutinin (DSA), Artocarpus agglutinin (ArA), Triticum agglutinin (TA)) were tested to investigate agglutination characteristics in patients with MI or angina pectoris without MI (AP) and healthy volunteers (HV) as control. RBC agglutination was analyzed by light absorbance of a stirred RBC suspension in a broad range in green and red light in an agglutimeter (amtec) for 15 min after lectin addition. Mean cell count in aggregates was estimated from light absorbance by mathematical model. Results: Each tested lectin induced agglutination of RBC. RCA led to the strongest agglutination of RBC (about 150 RBC per aggregate), while PHA, DSA, TA and ArA induced much slower agglutination (5-20 RBCs per aggregate). The speed of RBC-agglutination of patients with coronary heart disease was generally higher than that for HV. However, only PHA lectin induced agglutination was suitable to distinguish MI and HV among the tested lectins. Discussion and Conclusion: It is possible to differentiate between patients with MI and HP based on PHA-induced RBC-agglutination. We speculate that pathological changes induce modification of the composition of carbohydrates on the RBC membrane. Occurrence and distribution of carbohydrates on RBC membranes provide evidence about MI. The RBC-agglutination assay could be a valuable and fast diagnostic test for cardiac infarction. Acknowledgement: This work was supported by Sächsische Aufbaubank (SAB Project Nr: 11624/1845) and the BMBF Project MaDaKos (BMBF Project Nr. 990101-088. 12/2010-11/2013).