Study On The Application Value of Thromboelastic Graph in The Condition Assessment of Patients With Acute Myocardial Infarction

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Research Article

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Abstract

Background: To explore the application value of thromboelastic graph (TEG) in the assessment of patients with acute myocardial infarction (AMI).

Results: 1.R time (min), K time (min) and LY30(%) in the STEMI group were lower than those in the NSTEMI group, and the differences were statistically significant (P<0.05). The Angle(°) and MA values in the STEMI group were higher than those in the NSTEMI group, and the difference between the two groups was statistically significant (P<0.05). 2.R time(min), K time(min) and LY30(%) gradually decreased with the increase of the number of coronary artery lesions, while Angle(°) and MA value(mm) gradually increased. 3. R time (min), K time (min) and LY30(%) gradually decreased with the aggravation of coronary artery lesions, while Angle(°) and MA value (mm) gradually increased. 4. R time (min), K time (min) and LY30(%) were negatively correlated with Gensini score (r=-0.456, -0.418, -0.483, P<0.001).Angle(°) and MA value(mm) were positively correlated with Gensini score (r=0.531, 0.569, P<0.001).

Conclusion: Thromboelastic graph (TEG) can be used as an effective indicator for predicting the condition of patients with acute myocardial infarction (AMI), evaluating the severity of coronary artery disease, and guiding clinical treatment.

Introduction

In China, the prevalence trend of cardiovascular system diseases is obvious, and the number of patients continues to increase. At present, cardiovascular system diseases account for more than 40% of the deaths and are the first cause of death in China. An international cooperative study shows that the number of patients with acute myocardial infarction (AMI) in China has reached about 4 million in 2016, and the annual number of patients with AMI is expected to exceed 6.1 million in 2030 [1]. Thromboelastic graph (TEG) is a new technique for evaluating blood clotting function in recent years, which can dynamically record the interaction among blood components such as coagulation factors, platelets and fibrinogen, as well as the whole process from blood clot formation to fibrinolysis. At present, it has been widely used in different clinical fields such as perioperative coagulation function monitoring, anticoagulant and antiplatelet drugs efficacy monitoring and blood transfusion guidance. Thromboelastic graph(TEG) is commonly used to evaluate clotting function and guide the use of antiplatelet agents in patients with coronary atherosclerotic heart disease. Currently, no relevant studies have been used to evaluate the condition of patients with acute myocardial infarction (AMI). In view of this, thromboelastic graph (TEG) was tested in 200 patients with acute myocardial infarction (AMI) in this study to explore its clinical application value, which is reported as follows.

Materials And Methods

1.1 Research Objects: The cases were from the clinical data of 200 patients with definite diagnosis of acute myocardial infarction (AMI) admitted to the Heart Center of the First Affiliated Hospital of Xinjiang Medical University from January 2018 to December 2018. The diagnostic basis was referred to the fourth edition of the "Global Definition of myocardial infarction" standard [2] [3]. Among the data, 160 patients (80%) were STEMI patients and 40 patients (20%) were NSTEMI patients, including 170 males and 30 females, with an average age of 63.52±5.68 years. Exclusion criteria:Primary cardiomyopathy, valvular heart disease or other serious heart disease.Malignant tumor;Autoimmune diseases;Severe liver and kidney diseases;Previous history of coronary stent implantation or coronary artery bypass grafting surgery;The follow-up time in our hospital was less than 1 year.

1.2 Case Grouping: According to the American college of cardiology (ACC) of coronary blood flow image segmentation evaluation standard of coronary artery stenosis degree analysis and statistics of lesion blood vessel number, divided into three groups: **a.**Single-vessel lesion group: The stenosis degree of one vessel in left anterior descending branch, right coronary artery and left circumflex branch≥50%; The vascular lesions of diagonal branch, sharp branch and blunt branch were counted in the left anterior descending branch, right coronary artery and left circumflex branch respectively.**b.** double-vessel lesion group: The stenosis degree of two vessels of left anterior descending artery, right coronary artery and left circumflex artery ≥50%; Left main artery stenosis ≥50% was also included in this category.**c.** three-vessel lesion group: The stenosis degree of the three vessels of left anterior descending branch, right coronary artery and left circumflex branch was ≥50%. According to the American college of cardiology (ACC) coronary artery segmentation evaluation standard and Gensini score system for grouping coronary artery lesion severity [4] [6]**a.**Mild lesion group: <30 points; **b.**Moderate lesion group: 31~60 points; **c.**Severe lesion group: >60 points.

1.3 Thromboelastic graph (TEG) Detection method: Main instruments and reagentsSodium citrate anticoagulant tube (BD, USA); Thrombelastograph Analyzer TEG-5000 (USA); Kaolin reagent (with imported reagent for thromboelastic graph); Automatic clotting analyzer (CS-5100, Sysmex, Japan). Detecting thromboelastic graph (TEG) related indicators, including: R time(min), K time(min) and Angle(°), MA(mm), LY30(%).

1.4 Statistical analysis: Using SPSS22.0 software for data analysis. If the numerical variables are normally distributed, mean±standard deviation will be used for statistical description, and t-test or ANOVA will be used for comparison between groups. If the difference between groups is statistically significant, LSD method will be further used for pair-wise comparison. If the numerical variables do not follow the normal distribution, the median (interquarto space) is used for statistical description, and the non-parametric test (Mann-Whitney test or Kruskal-Wallis rank sum test) is used for comparison between groups. When the total difference between groups is statistically significant, Boferroni method is further used for multiple comparison.

Results

2.1 Comparison of thromboelastic graph(TEG) indicators between STEMI and NSTEMI patients: Among STEMI patients, R time(min), K time(min) and LY30(%) were lower than those of NSTEMI patients, and the differences were statistically significant (*P*<0.05). Among STEMI patients, Angle(°) and MA value(mm) were higher than those of NSTEMI patients, and the difference between the two groups was statistically significant (P < 0.05). See Table 1.

Table 1. Comparison of thromboelastic graph (TEG) indicators between STEMI and NSTEMI patients: Among STEMI patients.

	STEMI patients	NSTEMI patients	T or Z value	*P* value
R time(min)	3.9(3.0)	6.1(1.9)	-5.81	<0.001
K time(min)	1.9(2.1)	3.8(1.3)	-5.78	<0.001
Angle(°)	64.8(16.6)	49.5(15.1)	-7.52	<0.001
MA value(mm)	63.6(10.6)	54.3(11.7)	-6.48	<0.001
LY30(%)	1.1(1.0)	2.1(1.1)	-6.24	<0.001

2.2 Comparison of thromboelastic graph(TEG) indicators between groups with different number of coronary artery lesions: R time (min), K time (min), LY30(%), Angle(°) and MA value (mm) were not subject to normal distribution and homogeneity of variance test. Nonparametric Kruskal-Wallis rank sum test was used for analysis. Kruskal-wallis test results are as follows: Among the three groups, there were statistically significant differences in R time (min), K time (min), LY30(%), Angle(°) and MA value (mm) ($H_{R\ time}$ =120.651□*P*<0.001□$H_{K\ time}$ =123.072□*P*<0.001□H_{LY30} =139.194□*P*<0.001□H_{Angle} =118.754□P<0.001□$H_{MA\ values}$ =117.267□*P*<0.001)□The pairwise comparison results between multiple groups are as follows:□There was a difference in R time between the single-vessel disease group and the double-vessel disease group (adjusted *P*=0.002). There was a difference in R time between the single-vessel lesion group and the three-vessel lesion group (adjusted *P*< 0.001). There was a difference in R time between patients with double-vessel disease and those with three-vessel disease (adjusted *P*< 0.001). □There was a difference in K time between the single-vessel disease group and the double-vessel disease group (adjusted *P*=0.01). There was a difference in K time between the single-vessel disease group and the three-vessel disease group (adjusted *P*< 0.001). There was a difference in K time between the double-vessel disease group and the three-vessel disease group (adjusted *P*< 0.001).□ There was a difference in Angle(°) between the single-vessel disease group and the double-vessel disease group (adjusted *P*=0.007).There was a difference in Angle(°) between the single-vessel disease group and three-vessel disease group (adjusted *P*< 0.001).There was a difference in Angle(°) between the double-vessel disease group and the three-vessel disease group (adjusted *P*< 0.001).□ There was a difference in MA value between the single-vessel disease group and the double-vessel disease group (adjusted *P*=0.001). There was a difference in MA value between the single-vessel disease group and the three-vessel disease group (adjusted *P* <0.001). There was a difference in MA value between the double-vessel disease group and the three-vessel disease group (adjusted P<0.001).There was a difference in LY30(%) between the single-vessel disease group and the double-vessel disease group (adjusted P < 0.001).There was a difference in LY30(%) between the single-vessel disease group and the three-vessel disease group (adjusted P < 0.001). There was a difference in LY30(%) between the double-vessel disease group and the three-vessel disease group (adjusted P < 0.001). R time (min), K time (min) and LY30(%) gradually decreased with the increase of the number of coronary artery lesions, while Angle(°) and MA value (mm) gradually increased. See Table 2.

Table 2. Comparison of thromboelastic graph (TEG) indicators between groups with different number of coronary artery lesions.

	single-vessel disease	double-vessel disease	three-vessel disease	F or H value	P value
R time(min)	6.6(1.8)	4.7(1.3)	2.6(1.4)	120.651	<0.001
K time(min)	3.8(1.4)	3.1(1.3)	1.3(0.5)	123.072	<0.001
Angle(°)	48.3(12.8)	55.3(5.3)	70.3(8.8)	118.754	<0.001
MA value(mm)	52.9(7.1)	59.2(4.7)	68.8(9.3)	117.267	<0.001
LY30(%)	2.2(1.1)	1.5(0.3)	0.6(0.5)	139.194	<0.001

2.3 Comparison of thromboelastic graph(TEG) indicators in Gensini score system among different groups of patients: R time(min), K time(min), LY30(%), Angle(°) and MA values were not subject to normal distribution and homogeneity of variance test. Therefore, nonparametric Kruskal-Wallis rank sum test was used for analysis.Kruskal-wallis test results are as follows: Among the three groups, there were statistically significant differences in R time (min), K time (min), LY30(%), Angle(°) and MA value (mm)($H_{R\ time}$ =111.246,P<0.001$H_{K\ time}$ =120.209,P<0.001H_{LY30} =115.545,P<0.001H_{Angle} =110.836,P<0.001$H_{MA\ values}$ =109.101,P<0.001)The pairwise comparison results between multiple groups are as follows:There was no difference in R time between the mild lesion group and the moderate lesion group (adjusted P=0.054); There was a difference in R time between the mild lesion group and the severe lesion group (adjusted P< 0.001); There was a difference in R time between the moderate lesion group and the severe lesion group.(adjusted P< 0.001).There was no difference in K time between the mild lesion group and the moderate lesion group (adjusted P=0.071); There was a difference in K time between the mild lesion group and the severe lesion group (adjusted P< 0.001); There was a difference in K time between the moderate lesion group and the severe lesion group(adjusted P< 0.001). There was a difference in Angle(°) between the mild lesion group and the moderate lesion group (adjusted P=0.012); There was a difference in Angle(°) between the mild lesion group and the severe lesion group (adjusted P<0.001); There was a difference in Angle (°) between the moderate lesion group and the severe lesion group (adjusted P<0.001).There was a difference in MA values between the mild lesion group and the moderate lesion group(adjusted *P*=0.005); There was a difference in MA values between the mild lesion group and the severe lesion group (adjusted *P*< 0.001); There was a difference in MA values between the moderate lesion group and the severe lesion group (adjusted *P*< 0.001). There was a difference in LY30(%) between the mild lesion group and the moderate lesion group (adjusted *P*=0.004); There was a difference in LY30(%) between the mild lesion group and the severe lesion group (adjusted *P*< 0.001); There was a difference in LY30(%) between the moderate lesion group and the severe lesion group (adjusted *P*< 0.001).R time(min), K time(min) and LY30(%) gradually decreased with the aggravation of coronary artery lesions, while Angle(°) and MA values(mm) gradually increased. See Table 3.

Table 3. Comparison of thromboelastic graph (TEG) indicators in Gensini score system among different groups of patients.

	mild lesion group	moderate lesion group	severe lesion group	F or H value	*P* value
Rtime(min)	6.6(1.5)	5.4(2.0)	2.7(1.7)	111.246	<0.001
Ktime(min)	3.9(1.3)	3.2(1.2)	1.3(0.6)	120.209	<0.001
Angle(°)	49.1(10.6)	55.3(8.5)	69.8(9.5)	115.545	<0.001
MA values(mm)	51.6(5.6)	58.6(6.2)	68.4(8.9)	110.836	<0.001
LY30(%)	2.2(1.0)	1.5(0.5)	0.7(0.6)	109.442	<0.001

2.4 Correlation analysis between Gensini score and thromboelastic graph (TEG): R time(min), K time(min) and LY30(%) were negatively correlated with Gensini score (r= -0.456, -0.418, -0.483, *P*<0.001).Angle(°) and MA values(mm) were positively correlated with Gensini score (r=0.531, 0.569, *P*<0.001).See Figure 1.

Discussion

Coronary atherosclerotic heart disease is a type of heart disease in which atherosclerosis causes stenosis or occlusion of the lumen of the coronary arteries, leading to myocardial ischemia, hypoxia and even necrosis. In China, the proportion of deaths due to coronary atherosclerotic heart disease in the total number of deaths increased significantly, from 8.6% in 1990 to 15.2% in 2013. It is estimated that the total number of coronary heart disease deaths in China in 2013 was 1.394 million, which was 90% higher than that in 1990. At present, coronary atherosclerotic heart disease has become the first cause of death in six provinces, autonomous regions and municipalities in China[1]. The etiology of coronary atherosclerotic heart disease is complex, and the common risk factors include hypertension, diabetes, hyperlipidemia, smoking, obesity, etc. Meanwhile, abnormal coagulation and fibrinolysis play an important role in the occurrence and development of the disease. Unstable atherosclerotic plaque rupture is the initiating factor for the occurrence of acute myocardial infarction, which further causes platelet aggregation and fibrinogen activation, accelerates thrombosis, and leads to stenosis and occlusion of vascular lumen and acute myocardial ischemia. Therefore, to understand the coagulation and platelet functions of patients with acute myocardial infarction has an important role and significance for the diagnosis of the disease. Thromboelastic graph(TEG) is a new technique for evaluating blood clotting function in recent years, which can dynamically record the interaction among blood components such as coagulation factors, platelets and fibrinogen, as well as the whole process from blood clot formation to fibrinolysis. Thromboelastic graph(TEG) has nearly 20 standardized parameters, and more mature parameters in clinical application include: R time (min) : the time required for coagulation factor to fully activate fibrin formation, reflecting the activity of coagulation factor; K time (min), Angle(°) : the rate at which the blood clot strength reaches a certain level, which is mainly used to reflect the functional activity of fibrinogen; MA values(mm) : maximum blood clot strength and stability after formation, mainly used to reflect the function of platelets; LY30(%): the percentage of attenuation of blood clot amplitude within 30min after the occurrence of maximum amplitude of MA values, which is mainly used to evaluate fibrinolysis function. When LY30(%) exceeds 8%, hyperfibrinolysis is indicated. The above indicators have been widely used in different clinical fields, such as perioperative coagulation function monitoring, anticoagulant and antiplatelet drugs efficacy monitoring and blood transfusion guidance. However, it is rarely used to evaluate the condition of patients with acute myocardial infarction(AMI). Based on the pathological mechanism of AMI, the author used thromboelastic graph(TEG) related indicators to evaluate the severity of coronary artery lesions in patients with AMI, so as to provide effective guidance and reference for clinical diagnosis and treatment.

In this study, R time(min), K time(min) and LY30(%) in the STEMI group were lower than those in the NSTEMI group. The Angle(°) and MA values(mm) in the STEMI group were higher than those in the NSTEMI group, and there were significant differences in the thromboelastic graph(TEG) related indicators between the two groups. These results indicated that patients with STEMI had higher clotting activity and higher fibrin and platelet thrombus loads than those with NSTEMI.Guidelines for the Diagnosis and Treatment of acute ST-segment Elevation Myocardial Infarction (2019)[2] clearly indicate that the treatment principle for STEMI patients is to restore myocardial perfusion as soon as possible, and antithrombotic therapy (including antiplatelet and anticoagulant therapy) is necessary. Aspirin combined with one of the P2Y12 receptor inhibitors, dual antiplatelet therapy (DAPT) is the basis of antithrombotic therapy. For coronary angiography showed that thrombus burden in patients with severe, can be used by intravenous GPb/a receptor antagonist Tirofiban, help reduce slow flow or no reflow, improve myocardial microcirculation perfusion. In addition, anticoagulants such as heparin, enoxaparin, or pivastatin should be administered intraoperatively to STEMI patients undergoing percutaneous coronary intervention(PCI). Therefore,thromboelastic graph(TEG) can effectively reflect the condition of patients with acute myocardial infarction (AMI), and provide reference for individual medication.

At present, there are three main methods for scoring coronary angiography: Leaman scoring, Gensini scoring and SYNTAX scoring. Compared with Leaman score, Gensini score was more accurate in evaluating the possibility of cardiovascular and cerebrovascular adverse events in patients with acute coronary syndrome [8]. SYNTAX score seldom used in evaluation of patients with acute myocardial infarction(AMI), and for patients with stable coronary heart disease, it can assist to guide patients with multivessel lesions or left main disease to choose reasonable way of reascularization, and the higher the SYNTAX score, will predict who suffer coronary artery intervention(PCI) worse after the short-term clinical results of [9]. Therefore, Gensini scoring system was used to score coronary angiography in this study. The study showed that the Angle(°) and MA values(mm) gradually increased while the R time (min), K time (min) and LY30(%) gradually decreased with multi-vessel lesion or high Gensini score. Correlation analysis showed that R time (min), K time (min) and LY30(%) were negatively correlated with Gensini score, while Angle(°) and MA values(mm) were positively correlated with Gensini score.It further indicates that thromboelastic graph(TEG) related indicators is closely related to the severity of patients with acute myocardial infarction(AMI). The more severe the coagulation and fibrinolytic dysfunction, the more the number of coronary lesions and the more severe the stenosis. Therefore, thromboelastic graph(TEG) can be used as an effective indicator for predicting the condition of patients with acute myocardial infarction(AMI), evaluating coronary artery lesions, and guiding clinical treatment.

Declarations

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Contributors: Conceived and designed the research:XX,Y-TM.Performed the research: K-YW,Y-JT,T-TW.Analysed the data: K-YW,Y-JT.Quality control of the study and revision: XX,Y-TM.Wrote the paper:K-YW.

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Patient consent for publication: Obtained.

Ethics approval: This study complies with the Declaration of Helsinki and the protocol was approved by the ethics committees of the First Affiliated Hospital of Xinjiang Medical University. Because of the retrospective design of the study, the need to obtain informed consent from eligible patients was waived by the ethics committee.

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Data availability statement: The datasets used and/or analysed during the current study available from the corresponding author on reasonable request.

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Figures

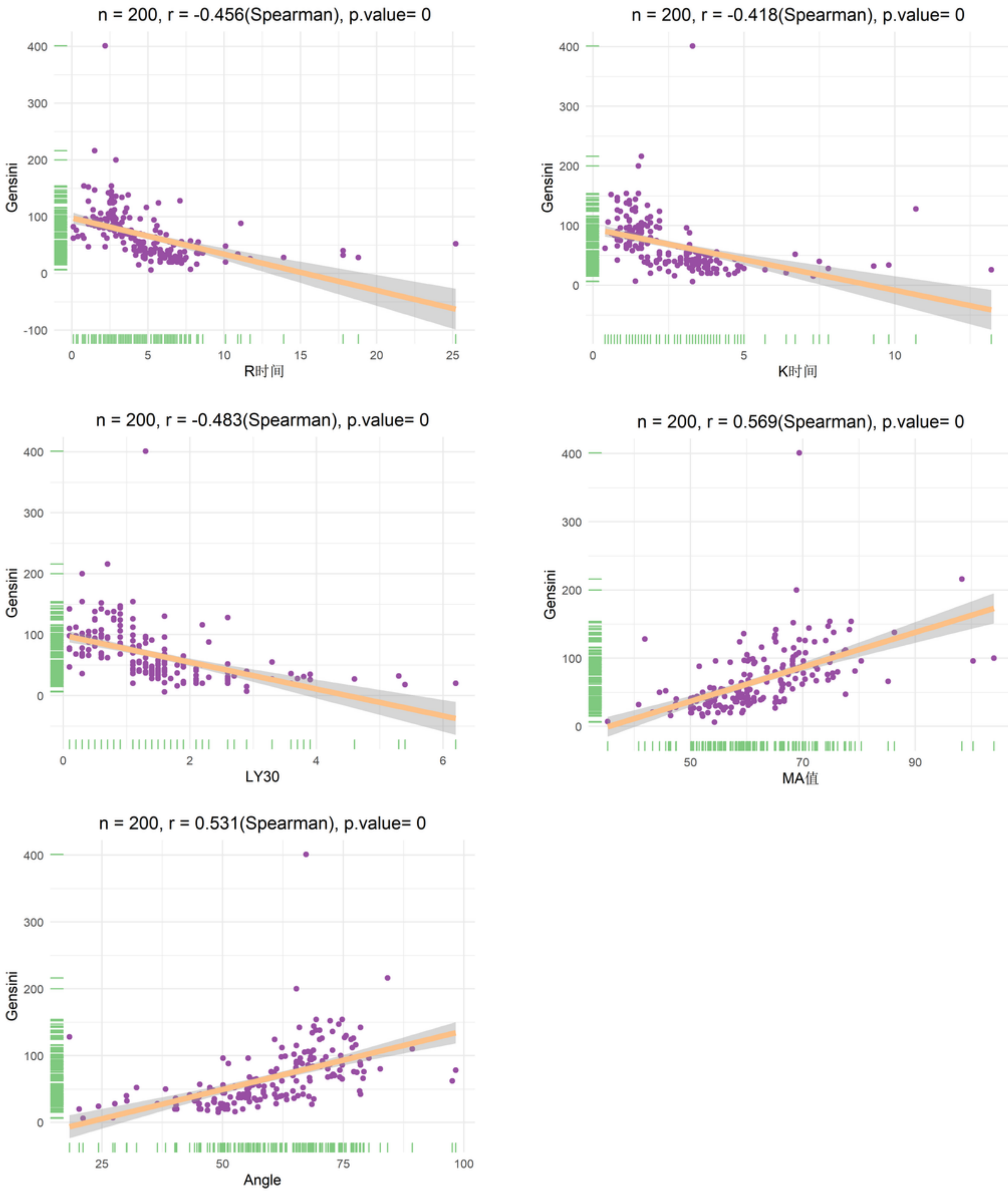

Figure 1

Correlation analysis between Gensini score and thromboelastic graph (TEG).