

The value of D-dimer, ESR and CRP in the Diagnosis of Deep Vein Thrombosis of Lower Limbs After Hip and Knee Joint Replacement

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Abstract

Objective: To investigate the diagnostic value of D-dimer, ESR and CRP in deep vein thrombosis (DVT) of lower extremity after hip and knee replacement.

Methods: Clinical data of 216 patients who underwent hip and knee replacement in our hospital from January 2018 to November 2020 were retrospectively analyzed. Among them, there were 86 patients with lower extremity deep vein thrombosis and 130 patients without lower extremity deep vein thrombosis. Preoperative blood D-dimer, prothrombin time, fibrinogen content, erythrocyte sedimentation rate (ESR), C-reactive protein (CRP), albumin and hemoglobin levels were collected. Chi-square test was used to compare the rate of deep vein thrombosis in lower limbs. The PSM propensity score matching method was used to select 86 patients from 130 patients without lower extremity deep vein thrombosis (DVT) as control group. The levels of D-dimer, albumin and hemoglobin in 172 patients were compared, and the diagnostic efficacy of D-dimer, ESR and CRP in the diagnosis of lower extremity deep vein thrombosis after hip and knee replacement was analyzed by ROC curve.

Results: ROC curve analysis results showed that: The optimal cut-off values of D-dimer, prothrombin time, ESR, CRP and age for the diagnosis of DVT of lower extremity after hip replacement were 1.745mg/L, 10.850s, 15.500mm/h, 2.375mg/L and 72 years old, respectively. The sensitivity was 71.8%, 66.7%, 61.5%, 94.9%, 71.8%, the specificity was 74.1%, 66.7%, 70.4%, 33.3%, 100%, and the area under the curve was 0.746, 0.683, 0.658, 0.651, 0.869. The optimal truncation value of D-dimer for the diagnosis of DVT of lower extremity after knee replacement was 0.285mg/L, the sensitivity was 78.7%, the specificity was 44.1%, and the area under the curve was 0.622.

Conclusion: The diagnostic value of D-dimer in the formation of lower extremity DVT after knee arthroplasty is higher than that after hip arthroplasty, but the diagnostic value of prothrombin time, ESR, CRP and age in the formation of lower extremity DVT after hip arthroplasty is higher than that after knee arthroplasty.

Background

Artificial joint replacement is an important method for the treatment of late hip and knee joint pain and dysfunction. Joint replacement can quickly and effectively reconstruct joint function, eliminate joint pain, correct deformity and dysfunction [[1]]. With the development of the aging population, the number of patients with joint degenerative diseases has increased, and artificial joint replacements have become more common. Many county hospitals have carried out joint replacements. At the same time, postoperative complications of joint replacement have also increased. Deep Vein Thrombosis (DVT) formation is a common perioperative complication of orthopedic hospitalized patients, and its incidence can reach 10%-80% [[2]]. The main causes of DVT in the lower limbs are the perioperative blood in patients with hypercoagulable state and slow braking blood flow in the lower limbs. The formation of DVT in the lower limbs can increase the patient's pain, lengthen the hospital stay, increase medical

expenses, and cause pulmonary embolism once it falls off. In severe cases, it can lead to death [[3]]. Perfect preoperative examination, correct application of anticoagulant drugs, and improve blood circulation can effectively prevent deep vein thrombosis of lower limbs, thereby reducing the burden on patients. Preoperative blood test is a routine test for artificial joint replacement. The blood D-dimer, fibrinogen and other levels can effectively assess the probability of deep vein thrombosis in the lower limbs after surgery. The author analyzed the clinical data of 216 patients who underwent hip and knee arthroplasty in our hospital from January 2018 to November 2020, and explored the diagnostic value of D-dimer in lower limb DVT after hip and knee arthroplasty.

Materials And Methods

1. normal information

1. Inclusion criteria: ☒Patients underwent hip and knee joint replacement surgery in our hospital from January 2018 to November 2020; ☒First hip and knee joint replacement surgery; ☒No lower extremity thrombosis before surgery; ☒Complete medical records, And approved by the patient and the hospital ethics committee.

2. Exclusion criteria: ☒Patients with a history of deep vein thrombosis or varicose veins in the lower extremities; ☒Patients with long-term use of anticoagulants for diseases such as cerebral thrombosis; ☒Patients with a history of malignant tumors or tuberculosis; ☒Patients with rheumatic diseases or blood Systemic disease; ☒Recent history of infection or application of antibiotics; ☒Recent surgery;

3. According to the inclusion and exclusion criteria, a total of 216 patients were included. There were 69 males and 147 females, aged 46–94 years old, with an average of (70.06 ± 10.03) years old. 77 cases of total knee replacement, 31 cases of unicondyle replacement, 35 cases of total hip replacement, and 73 cases of hemi-hip replacement. Among them, 86 patients had deep venous thrombosis of lower extremities after operation, and 130 patients had no deep venous thrombosis of lower extremities after operation. The diagnosis of DVT in the lower limbs is based on the postoperative deep vein color Doppler ultrasound.

2. Detection of research indicators

All study patients collected and analyzed D-dimer, prothrombin time, fibrinogen content, Erythrocyte Sedimentation Rate (ESR), C-Reactive Protein (CRP), white Protein and hemoglobin levels. Normal value range: D-dimer: 0-0.55mg/L, prothrombin time: 9.8–12.1 seconds, fibrinogen content: 2-4g/L, ESR: mm/h, CRP: 0-10mg/ L, albumin: 40-55g/L, hemoglobin: 130-175g/L.

Third, statistical methods

Use SPSS23.0 statistical software for statistical analysis. Measurement data conforming to the normal distribution are expressed by $\pm s$, and comparison between groups is performed by t test; measurement data not conforming to the normal distribution is expressed by median \pm quartile, and comparison

between the two groups is performed by Mann-Whitney U test; The data is expressed in frequency, and the χ^2 test is used for comparison between groups. $P < 0.05$ indicates that the difference is statistically significant.

Result

1. Comparison of the incidence of lower limb venous thrombosis after different replacement types

Among the 216 patients, 35 had total hip arthroplasty, 8 had deep venous thrombosis after operation, the incidence of thrombosis was 22.9%; 74 had hemi-hip arthroplasty, and 34 had deep venous thrombosis after the operation, and the incidence of thrombosis 46.6%; 77 cases of total knee arthroplasty, 25 cases of postoperative deep venous thrombosis of the lower extremities, the incidence of thrombosis was 32.5%; 31 cases of unicondyle replacement, 19 cases of postoperative deep venous thrombosis of the lower extremities, and the incidence of thrombosis 61.3%; See Table 1.

2. Based on age, gender and replacement type as the standard, using the PSM propensity score matching method, 86 patients were selected as the control group from 130 patients without deep vein thrombosis after operation, and the general information of 172 patients; see Table 2.

3. Comparison of the levels of D-dimer, albumin and hemoglobin between the thrombus group and the control group

The D-dimer level of patients in the thrombus group was 0.98 (0.378 ~ 3.463) mg/L, which was higher than the control group by 0.43 (0.238 ~ 0.893) mg/L, $P = 0.000$, the difference was statistically significant; the albumin of the patients in the thrombosis group was (38.806 ± 4.625) g/L, lower than the control group (41.003 ± 3.824) g/L, $P = 0.001$, the difference was statistically significant; the hemoglobin of the thrombosis group was (128.663 ± 15.776) g/L, lower than the control group (134.430 ± 12.842) g/L, $P = 0.009$, the difference is statistically significant; see Table 3.

Comparison of D-mer, albumin and hemoglobin levels in hip and knee replacement patients in thrombosis group

The D-dimer level of hip replacement patients was 3.25 (1.240 ~ 8.350) mg/L, which was higher than the D-dimer level of knee replacement patients by 0.45 (0.290 ~ 0.970) mg/L, $P = 0.000$, the difference was statistically significant Scientific significance; the albumin level of hip replacement patients was (36.199 ± 4.569) g/L, which was lower than that of knee replacement patients (40.969 ± 3.4269) g/L, $P = 0.000$, the difference was statistically significant; hip joint The hemoglobin level of replacement patients was (125.897 ± 16.665) g/L, which was lower than that of knee replacement patients (130.957 ± 14.785) g/L, $P = 0.140$, the difference was not statistically significant; see Table 4.

The diagnostic efficacy of D-dimer, prothrombin time, ESR, CRP, and age on the formation of DVT in lower limbs after hip replacement

ROC curve analysis results show that the best cut-off value of D-dimer in the diagnosis of lower extremity DVT after hip replacement is 1.745 mg/L, sensitivity is 71.8%, specificity is 74.1%, and area under the curve is 0.746 (95% CI: 0.622 ~ 0.870), $P = 0.001$, which is statistically significant; the best cutoff value of prothrombin time is 10.850s, the sensitivity is 66.7%, the specificity is 66.7%, and the area under the curve is 0.683 (95%CI: 0.551 ~ 0.816), $P = 0.012$, which is statistically significant; the best ESR cutoff value is 15.500mm/h, the sensitivity is 61.5%, the specificity is 70.4%, and the area under the curve is 0.658 (95%CI: 0.526 ~ 0.790), $P = 0.030$, statistically significant; the best cut-off value of CRP is 2.375 mg/L, sensitivity is 94.9%, specificity is 33.3%, area under the curve is 0.651 (95%CI: 0.514 ~ 0.787), $P = 0.039$, It is statistically significant; the best cut-off value for age is 72, the sensitivity is 71.8%, the specificity is 100%, the area under the curve is 0.869 (95%CI: 0.778 ~ 0.960), $P = 0.000$, which is statistically significant; see Fig. 1.

The diagnostic efficacy of D-dimer, prothrombin time, ESR, CRP, and age on the formation of lower limb DVT after knee arthroplasty

ROC curve analysis results show that the best cut-off value of D-dimer in the diagnosis of lower limb DVT after knee arthroplasty is 0.850 mg/L, sensitivity is 78.7%, specificity is 44.1%, and area under the curve is 0.622 (95% CI: 0.515 ~ 0.729), $P = 0.032$, statistically significant; the best cut-off value for age is 70.5 years, sensitivity is 34.0%, specificity is 86.4%, area under the curve is 0.589 (95%CI: 0.476 ~ 0.703), $P = 0.115$, no statistical significance; see Fig. 2.

Discuss

D-dimer is a specific degradation product of fibrinogen that is activated to form cross-linked fibrin and then hydrolyzed by plasmin [[4]]. It is the simplest fibrin degradation product and its main source The cross-linked fibrin clot dissolved by plasmin [[5]], its concentration can change with factors such as trauma, surgery, pregnancy, thrombosis, etc., to reflect the body's anticoagulation system and fibrinolytic system. Zhang Chengqing and other studies have shown that D-dimer can be used for the diagnosis of deep vein thrombosis and pulmonary embolism in the lower extremities [[6]], Jiang Y[[7]] reported the abnormal increase of D-dimer and the probability of thrombosis And the size is positively correlated, but some scholars have also shown that D-dimer has poor specificity in predicting thrombosis in the body [[8]]. This study showed that D-dimer [3.25 (1.240 ~ 8.350) mg/L] in thrombus group hip joint replacement patients was higher than that of knee replacement patients [0.45 (0.290 ~ 0.970) mg/L], and D-dimer The best cut-off value (1.745mg/L) for diagnosing the formation of lower limb DVT after hip replacement is higher than the best cut-off value (0.850mg/L) for knee replacement. This may be because most hip replacements are femoral neck fractures and trauma, Stress causes higher D-dimer. This study showed that the sensitivity (78.7%) of D-dimer in diagnosing lower limb DVT after knee arthroplasty is higher than that of hip joint (71.8%) and the specificity (44.1%) is less than hip joint (74.1%). The low specificity of D-dimer in diagnosing lower extremity DVT after knee arthroplasty may be due to: D-dimer level changes are not limited to lower extremity venous thrombotic diseases, but also manifested in coronary heart

disease, cerebral infarction and other diseases [9]; Patients were bedridden for a long time after replacement; The number of patients enrolled was limited.

Erythrocyte Sedimentation Rate (ESR) refers to the sinking speed of red blood cells in the serum in a static state, which is mainly affected by the negative charge on the cell membrane surface and decreases in a dispersed manner. When the negative charge on the cell membrane surface is affected, the erythrocyte sedimentation rate becomes abnormal, and its speed Accelerated, the red blood cell sedimentation rate increases [10], and ESR is mostly used as an indicator of inflammation and tumor. C-reactive protein (CRP) is an acute reactive protein synthesized by the liver. Under normal circumstances, the body's CRP content is very small. When the body has inflammation or trauma, the CRP level will increase sharply. It is usually used as the main indicator to judge inflammation and infection. [11]. This study showed that the best cut-off values of ESR and CRP for diagnosing lower limb DVT after hip replacement were 15.500mm/h and 2.375mg/L, respectively, the sensitivity was 61.5% and 94.9%, and the specificity was 70.4% and 33.3%, respectively. The areas under the curve are 0.658 and 0.651, respectively, which indicates that ESR and CRP can be used as diagnostic indicators for the formation of lower limb DVT after hip replacement. Chen Xiaolan [12] and other authors also found that ESR is significantly associated with deep vein thrombosis of the lower extremities. Foreign scholars believe that CRP can activate the body's complement system and cause vascular endothelial damage, induce the body to form a hypercoagulable state, and increase the risk of DVT [13]. The results of these studies are consistent with this study. This may be because: Inflammation is closely related to coagulation function, infection can promote the damage of the body's vascular endothelial cells, and then make the coagulation-fibrinolysis system more disordered [14]; The body's inflammatory state can promote the crystallization of urate in joints Intraluminal deposition, which in turn promotes deep vein thrombosis [15]. This study showed that the best cut-off value for DVT formation of lower limbs after hip arthroplasty was 72 years old, the sensitivity was 71.8%, the specificity was 100%, and the area under the curve was 0.869. Studies have reported that the risk of DVT in elderly patients is 6 times that of non-elderly patients [16]; Ahl et al. [17] believe that after the age of 40, every 10 years of age, the incidence of DVT will increase twice, when the age is over 80 years old Later, the incidence increased more significantly. This may be because elderly patients have less exercise, relatively slow blood flow, and high coagulation factors, which promote a high risk of thrombosis.

The shortcomings of this study: The prothrombin time, ESR, CRP, and age are far behind the hip joint in the diagnosis of lower limb DVT after knee arthroplasty; the number of cases is limited, which may affect the reliability of the results; this The research adopts retrospective research, and the inherent defects of retrospective research may affect the reliability of the results to a certain extent.

In summary: D-dimer has differences in the diagnosis of DVT formation after hip and knee arthroplasty. Different cut-off values can be used to more accurately determine the probability of DVT formation after hip and knee arthroplasty. Take preoperative measures to reduce the risk of DVT in the lower limbs after surgery. Prothrombin time, ESR, CRP, and age have great reference value in judging the formation of DVT in the lower limbs after hip replacement. It can evaluate the formation of DVT in the lower limbs after hip

replacement and reduce the risk of thrombosis. Prothrombin time, ESR, CRP, and age still need to be further studied in the diagnosis of DVT after knee arthroplasty.

Declarations

Acknowledgements

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Authors' contributions

Study conception and design: Fan,Zhang,Sun. Acquisition of data: Fan,Duan,Wan,Yuan,Zhou. Analysis and interpretation of data: Fan,Qiu,Wenyi Li,Xicheng Li.Drafting of manuscript: Fan, Xicheng Li.Critical revision: Xicheng Li. All authors read and approved the final manuscript.

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Availability of data and materials

Not applicable.

Ethics approval and consent to participate

The study was approved by the Ethics Committee of Hebei Provincial People's Hospital,Shijiazhuang, China. All experiments do not involve human or animals.

Consent for publication

Not applicable.

Competing interests

This material has not been published and is not under consideration elsewhere. The authors declare that they have no competing interests. All authors have read and contributed to the submitted manuscript, and there is no conflict of interest among the authors.

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Tables

Table 1

Comparison of incidence of lower limb venous thrombosis after different replacement types

displacement type	number of cases	Number of cases of deep vein thrombosis in lower extremity (%)	X2	P
THA	35	8(22.9%)	13.294	0.004
HA	73	34(46.6%)		
TKA	77	25(32.5%)		
UKA	31	19(61.3%)		

Table 2

General information of 172 patients

group	number of cases	gender		Age (years)	displacement type			
		male	female		TKA	UKA	THA	HA
Thrombus group	86	23	63	70.98 ± 10.22	25	19	8	34
The control group	86	23	63	64.00 ± 6.39	47	11	21	7

Table 3

Comparison of D-dimer, albumin and hemoglobin levels between thrombus group and control group

group	D-dimer (mg/L)	Albumin (g/L)	Hemoglobin (g/L)
Thrombus group	0.98(0.378 ~ 3.463)	38.806 ± 4.625	128.663 ± 15.776
The control group	0.43(0.238 ~ 0.893)	41.003 ± 3.824	134.430 ± 12.842
statistics	Z=-4.196	t = 3.395	t = 2.629
P	0.000	0.001	0.009

Table 4

Comparison of D-mer, albumin, and hemoglobin levels of hip and knee replacements in thrombosis group

group	D-dimer (mg/L)	Albumin (g/L)	Hemoglobin (g/L)
Hip arthroplasty	3.25(1.240 ~ 8.350)	36.199 ± 4.569	125.897 ± 16.665
Knee arthroplasty	0.45(0.290 ~ 0.970)	40.969 ± 3.4269	130.957 ± 14.785
statistics	Z=-5.830	t = 5.527	t = 1.491
P	0.000	0.000	0.140

Figures

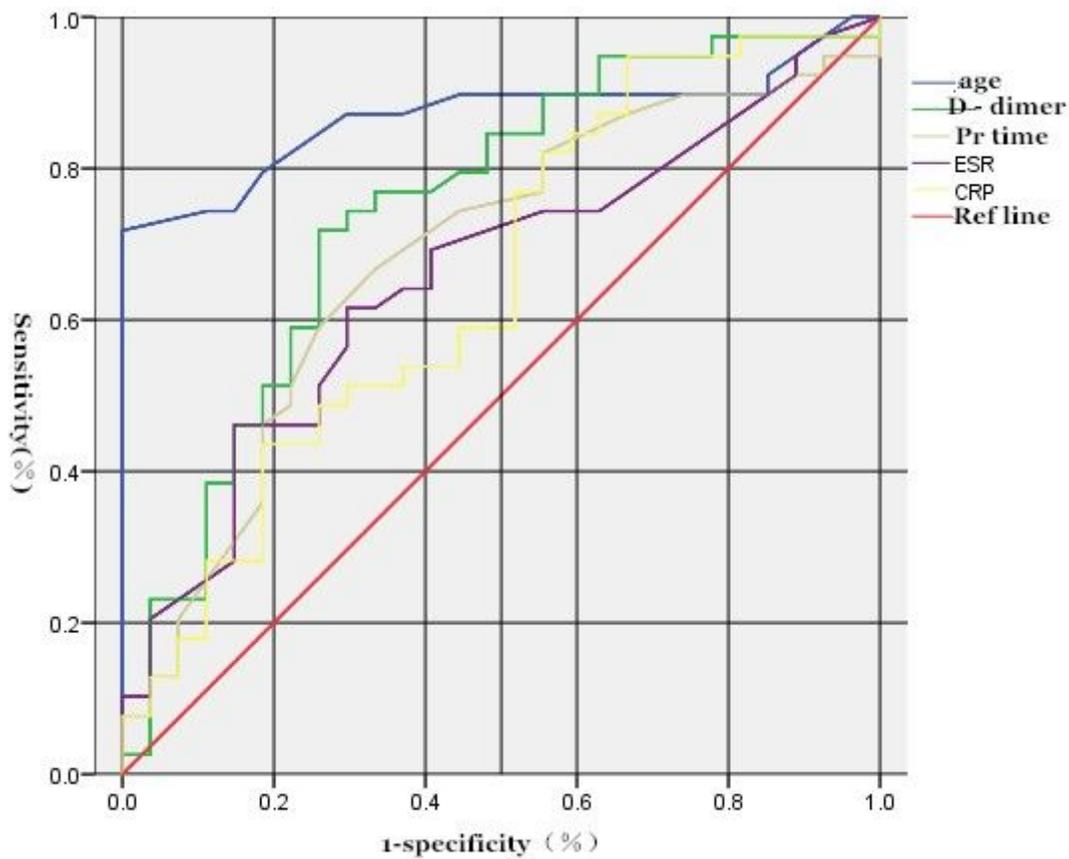


Figure 1

Subject ROC curve of D-dimer, prothrombin time, ESR, CRP, age diagnosis of lower limb DVT after hip replacement

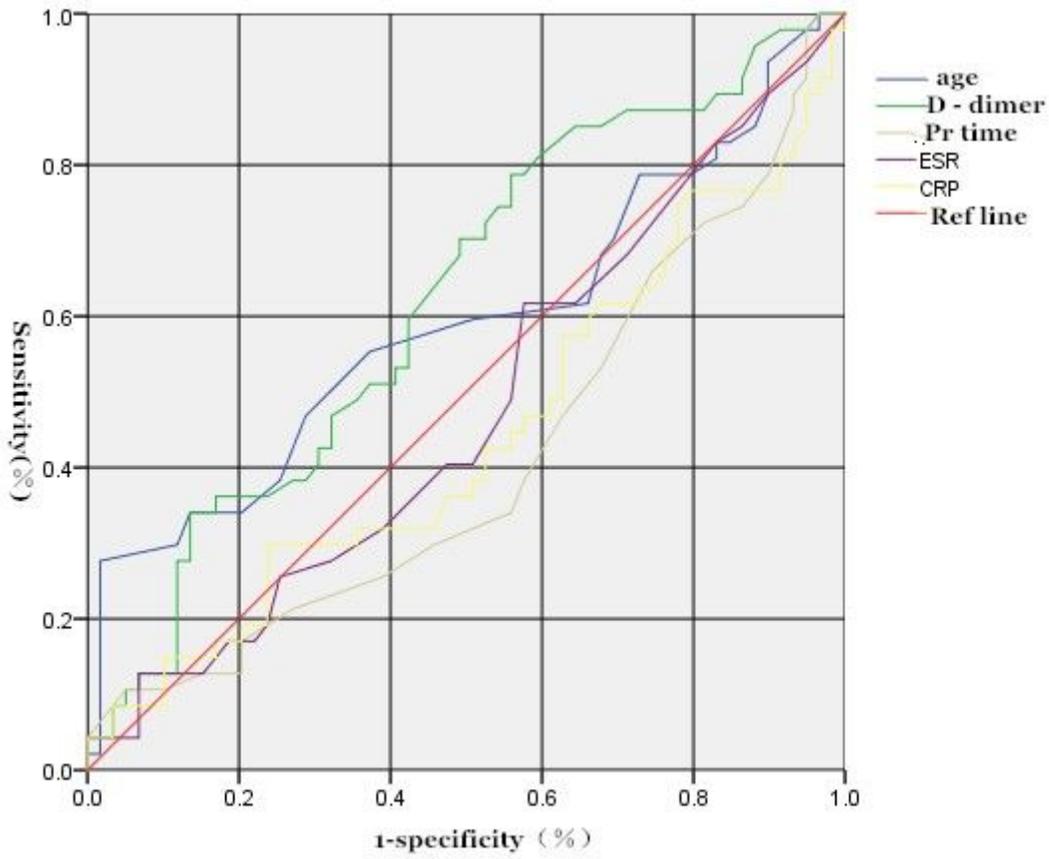


Figure 2

Subject ROC curve of D-dimer, prothrombin time, ESR, CRP, age diagnosis of lower limb DVT after knee arthroplasty