Original Article

Clinical and radiological differentiation between Trousseau syndrome and cardiogenic embolism: a retrospective case-control study

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Background: Trousseau syndrome (TS) is a thromboembolic event in cancer patients caused by abnormalities in coagulation and fibrinolytic mechanisms. Acute multiple cerebral infarction (AMCI) is a rare form of TS. This study aimed to discuss the differentiation of clinical and radiographic characteristics between TS and cardiogenic embolism (CE) with AMCI as the main manifestation.

Methods: We retrospectively analyzed 69 patients with TS-AMCI and 105 patients with CE-AMCI who were treated at Shandong Provincial Hospital between August 2018 and October 2022. The clinical baseline data, laboratory indices, and imaging characteristics of the two groups were compared. A logistic regression was used to analyze the risk factors of TS-AMCI, and receiver operating characteristic (ROC) curves were used to analyze the predictive value of the risk factors.

Results: In relation to the clinical data, there were statistically significant differences between the two groups of patients in terms of the lipid and coagulation indices. D-dimer [odds ratio (OR) =4.459, 95% confidence interval (CI): 1.871–10.625; P=0.001] and triglyceride (OR =6.001, 95% CI: 2.375–15.165; P<0.001) were independent risk factors for TS-AMCI. In relation to the radiographic characteristics, the infarctions in the TS-AMCI group were widely distributed in multiple arterial supply areas [23 (33.3%) *vs.* 10 (9.5%); P<0.001]. More importantly, bilateral anterior + posterior circulation was also an independent risk factor for TS-AMCI (OR =15.005, 95% CI: 1.757–128.17; P=0.013).

Conclusions: Unexplained AMCI in the cancer-prone age group, abnormalities in the lipid and D-dimer levels, and infarction foci involving multiple arterial blood supply areas suggested a high probability of TS.

Keywords: Trousseau syndrome (TS); cancer-related cerebral infarction; cardiogenic embolism (CE); acute multiple cerebral infarction (AMCI); magnetic resonance imaging (MRI)

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Introduction

Trousseau syndrome (TS) was originally described by the French physician Armand Trousseau in 1895 (1). By observing the progression of occult gastric cancer with wandering superficial phlebitis as the main manifestation, Trousseau discovered a correlation between malignancy and venous thrombosis triggered by blood in a hypercoagulable state (2,3). In recent years, this term has been widely used in clinical practice to describe hypercoagulable disorders occurring in the setting of malignant tumors, including wandering superficial thrombophlebitis, disseminated intravascular coagulation, arteriovenous thrombosis, and non-bacterial thrombotic endocarditis.

According to Trial of Org 10172 in Acute Stroke Treatment (TOAST) staging, there are five major categories of ischemic stroke: large artery atherosclerotic stroke, cardiogenic embolism (CE), small artery occlusive embolism, ischemic stroke due to other causes, and ischemic stroke of unknown origin (4). CE, which is most commonly caused by atrial fibrillation, is a common cause of acute multiple cerebral infarction (AMCI). However, as a less common manifestation of TS, AMCI may be considered a form of infarction caused by other stroke mechanisms (especially CE) (5). Thus, the identification of TS at an early stage is important, as patients with active cancer have worse prognoses and higher risks of stroke recurrence than those with other stroke causes, and a late diagnosis may delay treatment and further affect prognosis (6-9). TS and CE are fundamentally different; however, there are many similarities in the clinical features and imaging manifestations of both.

To date, most previous studies have focused on discussing the respective characteristics of CE or TS, and few comprehensive comparisons of the clinical and radiographic features of these diseases have been performed. Moreover, there is no unified conclusion on the diagnostic criteria of TS. Thus, the objectives of this study were as follows: (I) to comprehensively analyze the clinical and imaging differences between TS-AMCI and CE-AMCI; (II) to summarize the characteristic presentation of TS-AMCI; and (III) to reveal independent risk factors and determine their thresholds for TS-AMCI. We present this article in accordance with the STROBE reporting checklist (available at https://qims.amegroups.com/article/view/10.21037/qims-23-800/rc).

Methods

Study population

This study was a retrospective case-control study. Patients attending the Department of Neurology at Shandong Provincial Hospital between August 2018 and October 2022 were enrolled in this study. The search terms [("acute" AND "multiple") AND ("cerebral infarction" OR "stroke")] were used in the Picture Archiving and Communication System (GE HealthCare, Chicago, IL, USA). The TS-AMCI and CE-AMCI groups comprised 69 and 105 patients, respectively. The patients in both groups were matched for gender and age. The inclusion and exclusion criteria were determined jointly by clinical neurologists and radiologists. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved by the Ethics Committee of Shandong Provincial Hospital, and the requirement of individual consent for this retrospective analysis was waived.

To be eligible for inclusion in the TS-AMCI group, the patients had to meet the following inclusion criteria: (I) have clinical manifestations of acute neurological dysfunction; (II) have undergone diffusion-weighted imaging (DWI) sequences within 48 hours of onset that suggested multiple infarctions; (III) have AMCI, which was defined as infarctions that were spatially separated from each other (10); (IV) have <50% responsible artery stenosis; and (V) have pathologically confirmed malignant tumors. Patients were excluded from the TS-AMCI group if they met any of the following exclusion criteria: (I) had a hematologic disorder or intracranial tumor (primary or metastatic); (II) had a cerebral hemorrhage, had a cerebral contusion, had undergone cranial surgery, etc.; and (III) had heart disease prone to emboli; and/or (IV) had heart failure (left ventricular ejection fraction: <40%).

To be eligible for inclusion in the CE-AMCI group, the patients had to meet the following inclusion criteria: (I) have clinical manifestations of acute neurological dysfunction; (II) meet the diagnostic criteria of cardiogenic cerebral embolism in TOAST staging (3); (III) have undergone DWI sequences within 48 hours of onset that suggested multiple infarctions; (IV) have AMCI, which was defined as infarctions that were spatially separated from each other (10); and (V) have <50% responsible artery stenosis. Patients were excluded from the CE-AMCI

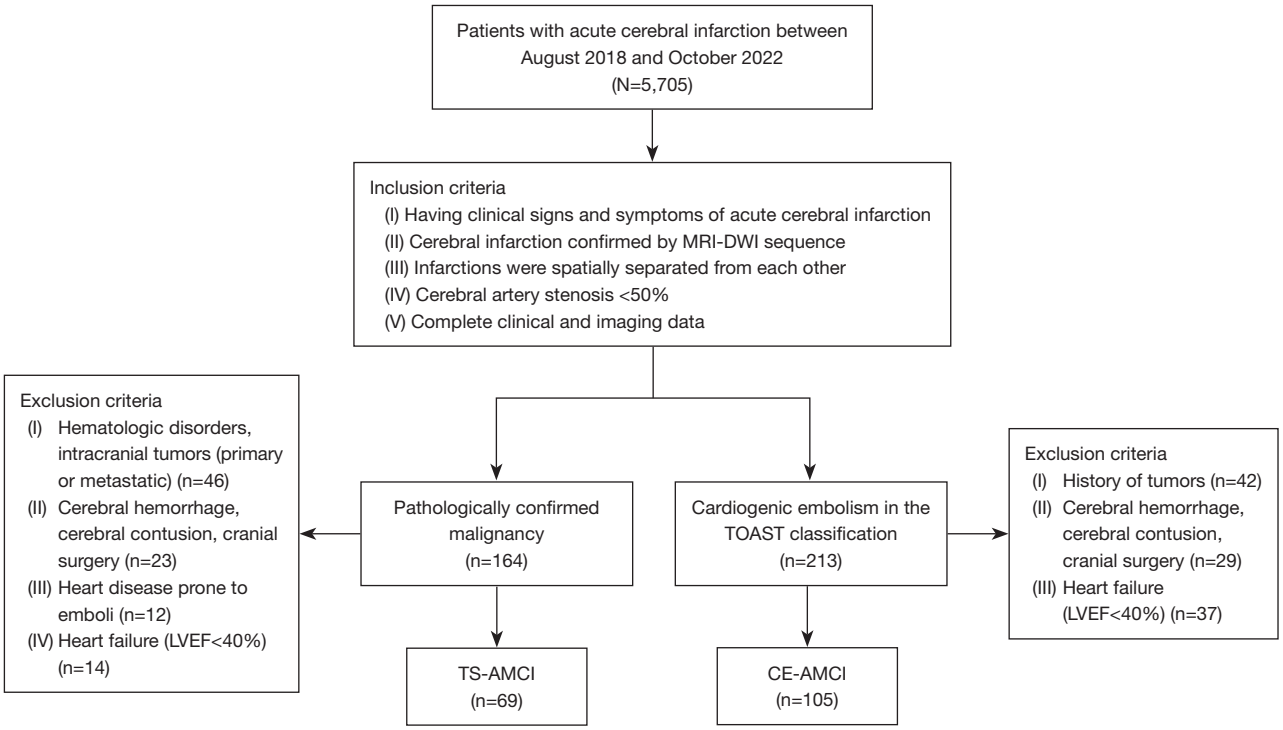

Figure 1 Flowchart of the patient selection process. MRI, magnetic resonance imaging; DWI, diffusion-weighted imaging; TOAST, Trial of Org 10172 in Acute Stroke Treatment; LVEF, left ventricular ejection fraction; TS, Trousseau syndrome; AMCI, acute multiple cerebral infarction; CE, cardiogenic embolism.

group if they met any of the following exclusion criteria: (I) had a confirmed diagnosis of various types of tumors; (II) had a cerebral hemorrhage, had a cerebral contusion, had undergone cranial surgery, etc.; and/or (III) had heart failure (left ventricular ejection fraction: <40%) (*Figure 1*).

Clinical characteristics

The following clinical data were collected from the patients: (I) baseline information, including sex, age, smoking, drinking, hypertension, diabetes, and hyperlipidemia; (II) laboratory test information, including routine blood reports, blood lipids [total cholesterol, triglyceride, high-density lipoprotein, and low-density lipoprotein (LDL)], coagulation [D-dimer, fibrinogen, fibrin degradation products (FDP), prothrombin time, thrombin time, and activated partial thromboplastin time], creatinine, uric acid, C-reactive protein (CRP), and cancer-related conditions (e.g., time of cancer diagnosis, type of pathology, metastasis, and cancer markers); and (III) other information, including treatment options and causes of death.

Radiographic manifestations

The patient magnetic resonance imaging (MRI) data included transaxial T1-weighted imaging, T2-weighted imaging, T2-fluid attenuated inversion recovery, and DWI (b =1,000 s/mm^2) sequences. Cerebrovascular evaluation included cerebral magnetic resonance angiography or computed tomography angiography. The number, location, distribution area, and maximum diameter of the infarctions in the DWI sequences were recorded separately. The infarctions were classified based on number as <10, ≥10, or patchy (i.e., the number could not be accurately estimated). The diameter was taken as the diameter of the largest infarctions and classified as <10 mm, 10–30 mm, and >30 mm. The distribution of the infarctions was divided into five forms: unilateral anterior circulation, bilateral anterior circulation, unilateral anterior

+ posterior circulation, bilateral anterior + posterior circulation, and posterior circulation according to the region of cerebral artery drainage. Two radiologists, each with over five years of clinical experience, acquired the data.

Statistical methods

The statistical analysis was conducted using SPSS version 25.0 (IBM Corp., Armonk, NY, USA) statistical software. The count data are expressed as the number (%). We performed normality tests on the measurement data. Data conforming to a normal distribution are expressed as the mean ± standard deviation, while those not conforming to a normal distribution are expressed as the median (P25, P75). The measurement data were analyzed using the Student's *t*-test or Mann-Whitney *U* test according to whether they conformed to a normal distribution, and the count data were analyzed using the chi-square test. We performed univariate logistic regression analyses for the clinical characteristics without multicollinearity, and then extracted the factors that were significant in the univariate analyses for the multivariate analyses. Finally, sensitivity analyses of the clinically independent risk factors associated with TS were performed. P values were calculated as two-sided, and a P value <0.05 indicated a statistically significant difference.

Results

Analysis of clinical characteristics

The mean age of the patients in the TS-AMCI group was 66.55±9.36 years, and there were 49 male and 20 female patients in this group. The primary cancer types were digestive system cancers (n=32, 46.4%), lung cancers (n=24, 34.8%), urologic cancers (n=6, 8.7%), genital cancers (n=3, 4.3%), and cancers in other sites (n=4, 5.8%). The mean age of the patients in the CE-AMCI group was 64.49±11.67 years, and there were 66 males and 39 females in this group. The cardiogenic factors included atrial fibrillation (n=70, 66.7%), myocardial infarction (n=12, 11.4%), rheumatic heart disease (n=9, 8.6%), patent foramen ovale (n=5, 4.8%), cardiomyopathy (n=4, 3.8%), infective endocarditis (n=3, 2.9%), and left atrial mucinous tumors (n=2, 1.9%).

No significant differences were found between the two groups in terms of sex, age, smoking, drinking, hypertension, and hyperlipidemia. Conversely, more patients had diabetes in the CE-AMCI group than the TS-AMCI group [30 (28.6%) *vs.* 8 (11.6%); P=0.008]. Among the laboratory indices, the TS-AMCI group had lower hemoglobin [119.00 (99.00, 135.00) *vs.* 136.00 (126.00, 148.00) g/L; P<0.001), creatinine [63.70 (57.10, 72.23) *vs.* 71.40 (61.10, 85.05) μmol/L; P=0.004], and uric acid (293.80±104.72 *vs.* 335.08±98.88 μmol/L; P=0.007) levels than the CE-AMCI group. However, the TS-AMCI group had higher triglyceride [1.39 (1.08, 2.21) *vs.* 1.15 (0.96, 1.38) mmol/L; P<0.001], LDL [2.72 (2.40, 3.26) *vs.* 2.33 (1.94, 3.08) mmol/L; P=0.004], D-dimer [2.21 (0.76, 7.41) *vs.* 0.43 (0.24, 0.88) mg/L; P<0.001], FDP [3.79 (1.44, 12.11) *vs.* 1.30 (0.87, 2.50) μg/mL; P<0.001], and CRP [4.98 (1.40, 28.41) *vs.* 2.30 (1.42, 8.63) mg/L; P=0.019] levels than the CE-AMCI group (*Table 1*).

Comparison of radiographic characteristics

In relation to infarction distribution, 53 patients in the CE-AMCI group compared to only 16 in the TS-AMCI group presented with unilateral anterior circulation [53 (50.5%) *vs.* 16 (23.2%); P<0.001]. Additionally, 23 patients in the TS-AMCI group presented with bilateral anterior + posterior circulation compared to only 10 in the CE-AMCI group [23 (33.3%) *vs.* 10 (9.5%); P<0.001]. However, no between-group differences were found for the other distribution types. In relation to the number of infarctions, 41 and 79 patients had <10 infarctions in the TS-AMCI and CE-AMCI groups, respectively [41 (59.4%) *vs.* 79 (75.2%); P=0.027], while 20 and 15 patients had ≥10 infarctions in the TS-AMCI and CE-AMCI groups, respectively [20 (29.0%) *vs.* 15 (14.3%); P=0.018]. The difference was not significant between the two groups when the infarct foci presented as patchy. The infarct diameters were not significantly different between the two groups (*Table 2*).

Independent risk factors for TS-AMCI

To explore the correlation between the clinical and imaging characteristics in TS-AMCI, a logistic regression analysis was performed (*Tables 3*,*4*). In the multifactorial logistic regression analysis, triglyceride [odds ratio (OR) =6.001, 95% confidence interval (CI): 2.375–15.165; P<0.001], and D-dimer (OR =4.459, 95% CI: 1.871–10.625; P=0.001) were independent risk factors for TS. In terms of the imaging features, the probability of a diagnosis of TS was approximately 15 times higher than that of CE when the

Table 1 Comparison of the clinical characteristics between the TS-AMCI and CE-AMCI groups

Characteristic	TS-AMCI (N=69)	CE-AMCI (N=105)	P value
Sex (male)	49 (71.0)	66 (62.9)	0.266
Age, years	66.55±9.36	64.49±11.67	0.109
Smoking	28 (40.6)	42 (40.0)	0.939
Drinking	29 (42.0)	50 (47.6)	0.469
Hypertension	31 (44.9)	46 (43.8)	0.885
Diabetes	8 (11.6)	30 (28.6)	0.008*
Hyperlipidemia	20 (29.0)	19 (18.1)	0.094
White blood cell count (10^9/L)	7.06 (5.52, 9.52)	6.73 (5.47, 8.01)	0.241
Platelet count (10^9/L)	221.00 (152.5, 268.50)	210.00 (168.00, 255.50)	0.364
Hemoglobin (g/L)	119.00 (99.00, 135.00)	136.00 (126.00, 148.00)	<0.001*
Lymphocytes absolute value (%)	1.43 (0.98, 1.71)	1.40 (0.99, 2.03)	0.410
Monocytes absolute value (%)	0.50 (0.39, 0,76)	0.50 (0.40, 0.60)	0.515
Neutrophil absolute value (%)	4.47 (3.62, 7.00)	4.15 (3.34, 5.47)	0.139
Creatinine (μmol/L)	63.70 (57.10, 72.23)	71.40 (61.10, 85.05)	0.004*
Uric acid (μmol/L)	293.80±104.72	335.08±98.88	0.007*
Total cholesterol (mmol/L)	4.37 (3.80, 5.16)	4.08 (3.65, 4.97)	0.107
Triglyceride (mmol/L)	1.39 (1.08, 2.21)	1.15 (0.96, 1.38)	<0.001*
HDL (mmol/L)	1.09±0.40	1.18±0.30	0.107
LDL (mmol/L)	2.72 (2.40, 3.26)	2.33 (1.94, 3.08)	0.004*
CRP (mg/L)	4.98 (1.40, 28.41)	2.30 (1.42, 8.63)	0.019*
D-dimer (mg/L)	2.21 (0.76, 7.41)	0.43 (0.24, 0.88)	<0.001*
Fibrinogen (g/L)	3.40 (2.82, 4.51)	3.23 (2.63, 3.84)	0.145
FDP (μg/mL)	3.79 (1.44, 12.11)	1.30 (0.87, 2.50)	<0.001*
PT (s)	12.70 (11.35, 13.95)	12.40 (11.50, 13.90)	0.973
TT (s)	14.60 (13.75, 16.25)	14.60 (13.70, 16.55)	0.572
APTT (s)	30.70 (27.65, 34.00)	31.00 (28.00, 35.40)	0.481

The data are presented as the number (%), mean ± standard deviation or median (P25, P75). *, P<0.05. TS, Trousseau syndrome; AMCI, acute multiple cerebral infarction; CE, cardiogenic embolism; HDL, high-density lipoprotein; LDL, low-density lipoprotein; CRP, C-reactive protein; FDP, fibrin degradation product; PT, prothrombin time; TT, thrombin time; APTT, activated partial thromboplastin time.

distribution of infarct foci was bilateral anterior + posterior circulation (OR =15.005, 95% CI: 1.757–128.17; P=0.013). Conversely, the unilateral anterior circulation pattern was negatively correlated with a diagnosis of TS (OR =0.364, 95% CI: 0.164–0.809; P=0.013).

Figure 2 and *Table 5* show the values of triglyceride and D-dimer levels in predicting the development of TS-AMCI. The areas under the curve (AUCs) for the triglyceride and D-dimer levels were 0.686 and 0.849, respectively. Using the triglyceride level at a threshold of 1.385 mmol/L yielded a sensitivity of 52.2% and a specificity of 78.1%. Thus, while a correlation was found between elevated

Table 2 Comparison of the imaging characteristics between the TS-AMCI and CE-AMCI groups

Infarctions characteristic	TS-AMCI (N=69)	CE-AMCI (N=105)	P value
Distribution, n (%)			
Unilateral anterior circulation	16 (23.2)	53 (50.5)	<0.001*
Bilateral anterior circulation	7 (10.1)	7 (6.7)	0.409
Unilateral anterior circulation + posterior circulation	14 (20.3)	22 (21.0)	0.916
Bilateral anterior circulation + posterior circulation	23 (33.3)	10 (9.5)	<0.001*
Posterior circulation	9 (13.0)	13 (12.4)	0.898
Number (pieces), n (%)			
<10	41 (59.4)	79 (75.2)	0.027*
≥10	20 (29.0)	15 (14.3)	0.018*
Patchy	8 (11.6)	11 (10.5)	0.817
Diameter, n (%)			
<10 mm	34 (49.3)	54 (51.4)	0.781
10–30 mm	24 (34.8)	39 (37.1)	0.751
>30 mm	11 (15.9)	12 (11.4)	0.390

The data are presented as the number (%). *, P<0.05. TS, Trousseau syndrome; AMCI, acute multiple cerebral infarction; CE, cardiogenic embolism.

triglyceride levels and TS-AMCI, the sensitivity was low and it was insufficient to make an accurate diagnosis. Using the D-dimer level at a threshold of 1.125 mg/L yielded a sensitivity of 71.0% and specificity of 81.9%. Thus, the D-dimer level was more clinically valuable in diagnosing TS-AMCI than the triglyceride level.

Discussion

Several studies have summarized and analyzed the imaging characteristics of TS or CE. Research has reported that acute multiple regional foci of infarction in patients with cardiogenic cerebral embolism are distributed bilaterally in hemispheres involving different vascular regions (11). In the case of TS, many studies have suggested that such patients present with the "Three Territory Sign" (TTS); that is, an acute ischemic DWI-positive lesion involving bilateral anterior and posterior circulation (12-14). Nouh *et al.* showed that the "TTS" in cancer- related ischemic stroke is six times more likely than in atrial fibrillation-related ischemic stroke (14). TS and CE have radiological commonalities; however, the infarct foci areas may differ.

In terms of clinical characteristics, lower hemoglobin and higher CRP levels in the TS-AMCI group were associated with a high wasting state and secondary infection due to malignant tumors. We hypothesized that the decreased oxygen-carrying capacity due to reduced hemoglobin further aggravated the occurrence of stroke. A previous study reported that high-sensitivity CRP levels were positively associated with the risk of patients developing ischemic stroke (15).

In terms of lipids, the TS-AMCI group had decreased triglyceride and LDL levels, indicating that patients with TS were more likely to have abnormal lipid metabolism. Hyperlipidemia can cause endothelial dysfunction and oxidative stress, leading to increased thrombosis risk (16).

Most notably, the D-dimer and FDP levels were significantly higher in the TS-AMCI group than the CE-AMCI group (P<0.001), suggesting that malignancy was more likely to cause a hypercoagulable state and hyperfibrinolysis. A previous study noted that hypercoagulability occurs in TS patients because cancer cells activate the coagulation and fibrinolytic systems by releasing procoagulant factors or stimulating the procoagulant activity of other cells (17). The D-dimer and triglyceride levels were independent risk factors for TS-AMCI, with the D-dimer level having a higher diagnostic value than the triglyceride level. The sensitivity and

Table 3 Logistic regression analysis of the clinical factors associated with TS-AMCI

Characteristic	Univariate		Multivariate	
	OR (95% CI)	P value	OR (95% CI)	P value
Sex (male)	0.691 (0.359–1.328)	0.267		
Age	1.018 (0.989–1.048)	0.220		
White blood cell count	1.137 (1.014–1.275)	0.028*	0.996 (0.805–1.232)	0.972
Platelet count	1.000 (0.999–1.001)	0.598		
Hemoglobin	0.967 (0.953–0.982)	<0.001*	0.988 (0.965–1.012)	0.316
Lymphocytes absolute value	0.785 (0.493–1.250)	0.307		
Monocytes absolute value	2.930 (0.669–12.821)	0.154		
Neutrophil absolute value	1.143 (1.000–1.307)	0.051		
Creatinine	0.983 (0.968–0.998)	0.030*	0.991 (0.965–1.017)	0.482
Uric acid	0.996 (0.992–0.999)	0.009*	0.996 (0.990–1.002)	0.231
Triglyceride	3.605 (1.960–6.629)	<0.001*	6.001 (2.375–15.165)	<0.001*
Total cholesterol	1.301 (0.966–1.752)	0.083		
HDL	0.474 (0.190–1.180)	0.109		
LDL	1.792 (1.197–2.682)	0.005*	1.224 (0.591–2.536)	0.586
CRP	1.027 (1.010–1.044)	0.002*	1.015 (0.992–1.038)	0.206
D-dimer	2.792 (1.796–4.341)	<0.001*	4.459 (1.871–10.625)	0.001*
Fibrinogen	1.131 (0.913–1.401)	0.260		
FDP	1.341 (1.167–1.541)	<0.001*	0.788 (0.555–1.120)	0.184

*, P<0.05. TS, Trousseau syndrome; AMCI, acute multiple cerebral infarction; OR, odds ratio; CI, confidence interval; HDL, high-density lipoprotein; LDL, low-density lipoprotein; CRP, C-reactive protein; FDP, fibrin degradation product; PT, prothrombin time; TT, thrombin time; APTT, activated partial thromboplastin time.

specificity were good when a D-dimer level of 1.125 mg/L was used as the threshold value.

Further, the analysis of the primary cancers showed that digestive system cancers were the most common type of malignancy, and adenocarcinoma was the predominant type. Similarly, many studies have shown that adenocarcinoma is an important risk factor for developing cerebral infarction in patients with TS (18,19). This may be due to the fact that mucins are secreted directly into the bloodstream by adenocarcinoma cells and induce hypercoagulability (17).

Among the imaging characteristics, TS-AMCI was more likely to cause multiple emboli with wider dissemination. Conversely, infarcts caused by cardiogenic factors were fewer and more concentrated. This is related to another possible mechanism of TS (i.e., non-infectious endocarditis); the organisms are small and difficult to detect by transesophageal echocardiography (TEE) (20). In terms of the distribution of infarctions, bilateral anterior + posterior circulation was predominant in the TS-AMCI group, whereas unilateral anterior circulation was more common in the CE-AMCI group (*Figures 3*,*4*).

Further, in this study, 11 patients who presented with AMCI as the first symptom were diagnosed with malignancy during treatment or at a later follow-up point. TS with AMCI as the first symptom appears to garner clinicians' attention, as the presentation is rare. Cerebral infarction is the first manifestation of an occult malignancy, is mainly caused by specific cancer-related factors, has a poor prognosis, and is correlated with the severity of neurological deficits (21). Once diagnosed, TS patients require aggressive treatment to delay progression. Currently, low-molecular weight heparin is the first-line drug recommended for the treatment of TS. A meta-analysis found that compared with

Table 4 Logistic regression analysis of the imaging factors associated with TS-AMCI

Infarctions characteristic	Univariate		Multivariate	
	OR (95% CI)	P value	OR (95% CI)	P value
Distribution				
Unilateral anterior circulation	0.296 (0.150–0.583)	<0.001*	0.364 (0.164–0.809)	0.013*
Bilateral anterior circulation	0.633 (0.212–1.891)	0.412		
Unilateral anterior circulation + posterior circulation	1.041 (0.491–2.208)	0.916		
Bilateral anterior circulation + posterior circulation	4.750 (2.089–10.803)	<0.001*	15.005 (1.757–128.17)	0.013*
Posterior circulation	0.942 (0.379–2.340)	0.898		
Number (pieces)				
<10	2.075 (1.079–3.989)	0.029*	1.139 (0.389–3.336)	0.812
≥10	0.480 (0.192–0.868)	0.020*	0.182 (0.019–1.783)	0.144
Patchy	0.892 (0.340–2.345)	0.817		
Diameter (mm)				
<10	1.090 (0.594–2.001)	0.781		
10–30	1.108 (0.588–2.089)	0.751		
>30	1.470 (0.609–3.549)	0.392		

*, P<0.05. TS, Trousseau syndrome; AMCI, acute multiple cerebral infarction; OR, odds ratio; CI, confidence interval.

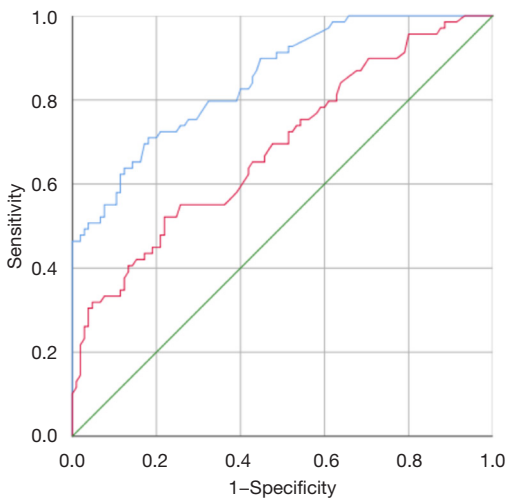

Figure 2 ROC curves for triglyceride and D-dimer. The blue line represents D-dimer; the red line represents triglyceride; the green line represents the reference line. ROC, receiver operating characteristic.

unfractionated heparin, mortality was significantly lower after three months of low-molecular heparin treatment (OR =0.71; 95% CI: 0.52–0.98), and there was no increased risk of bleeding (22). According to the latest American Society of Clinical Oncology (ASCO) clinical trial guidelines, patients at high risk of cancer (Khorana ≥2 points) can take oral apixaban, rivaroxaban, or low-molecular heparin for thromboprophylaxis in the absence of bleeding risk (23,24).

This study had some limitations. First, we did not exclude the effects of therapeutic measures, such as drug use and surgery. Second, as a retrospective analysis, we were unable to perform relevant tests to clarify the source of the emboli. Finally, TEE and aortic arch-related examinations were not performed, and potential coexisting causes of CE were not ruled out. The effects of drugs and surgery on the prognosis of patients should be considered in future research. Additionally, the probability of developing malignancy in patients with AMCI at first presentation can be prospectively analyzed, and further TEE and aortic arch-

Table 5 Correlation analysis of the areas under the curves

Characteristic	Threshold	TPR	TNR	AUC	OR	95% CI	P value
Triglyceride (mmol/L)	1.385	0.522	0.781	0.686	6.001	2.375–15.165	<0.001*
D-dimers (mg/L)	1.125	0.710	0.819	0.849	4.459	1.871–10.625	0.001*

*, P<0.05. TPR, true positive rate; TNR, true negative rate; AUC, area under the curve; OR, odds ratio; CI, confidence interval.

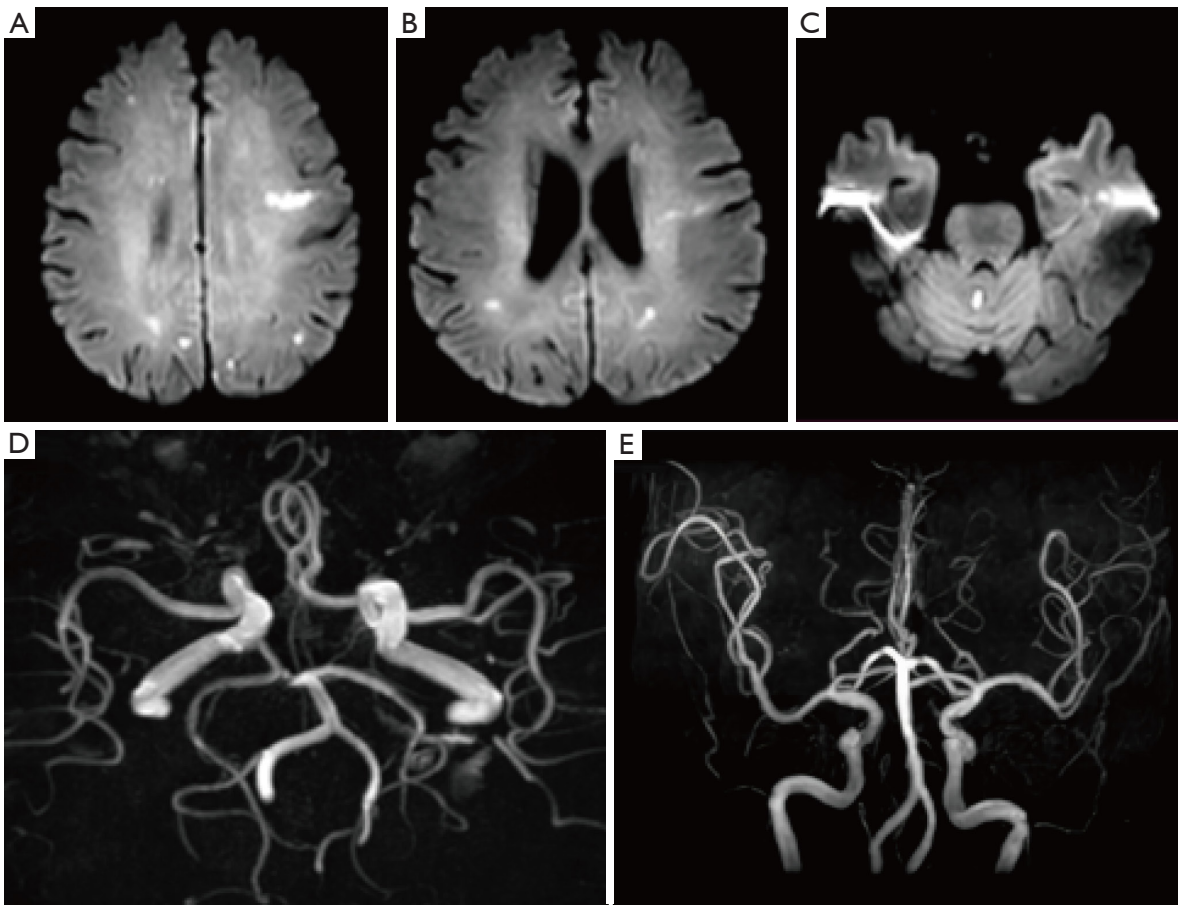

Figure 3 A 75-year-old, male patient with TS. (A-C) The DWI sequence showed multiple speckles of diffusion restriction in the bilateral subcortical, corona radiata, and cerebellar earthworms. (D,E) MRA showed mild cerebral arteriosclerosis with no significant luminal stenosis or dilatation; the right anterior cerebral artery originates from the left internal carotid artery. TS, Trousseau syndrome; DWI, diffusion-weighted imaging; MRA, magnetic resonance angiography.

related examinations should be performed in patients with suspected thrombosis.

Conclusions

We found that TS-AMCI and CE-AMCI still showed some clinical and imaging variability, especially in terms of lipids, coagulation, and the distribution of infarct foci. TS is relatively rare clinically; however, its early diagnosis is significant for improving the hypercoagulable state of blood and patient prognosis. Notably, the detection of occult malignancies with unexplained AMCI as the first manifestation is highly valuable for clinical purposes. However, studies with larger sample sizes and more comprehensive examinations are needed to justify the diagnostic value of our findings in clinical practice.

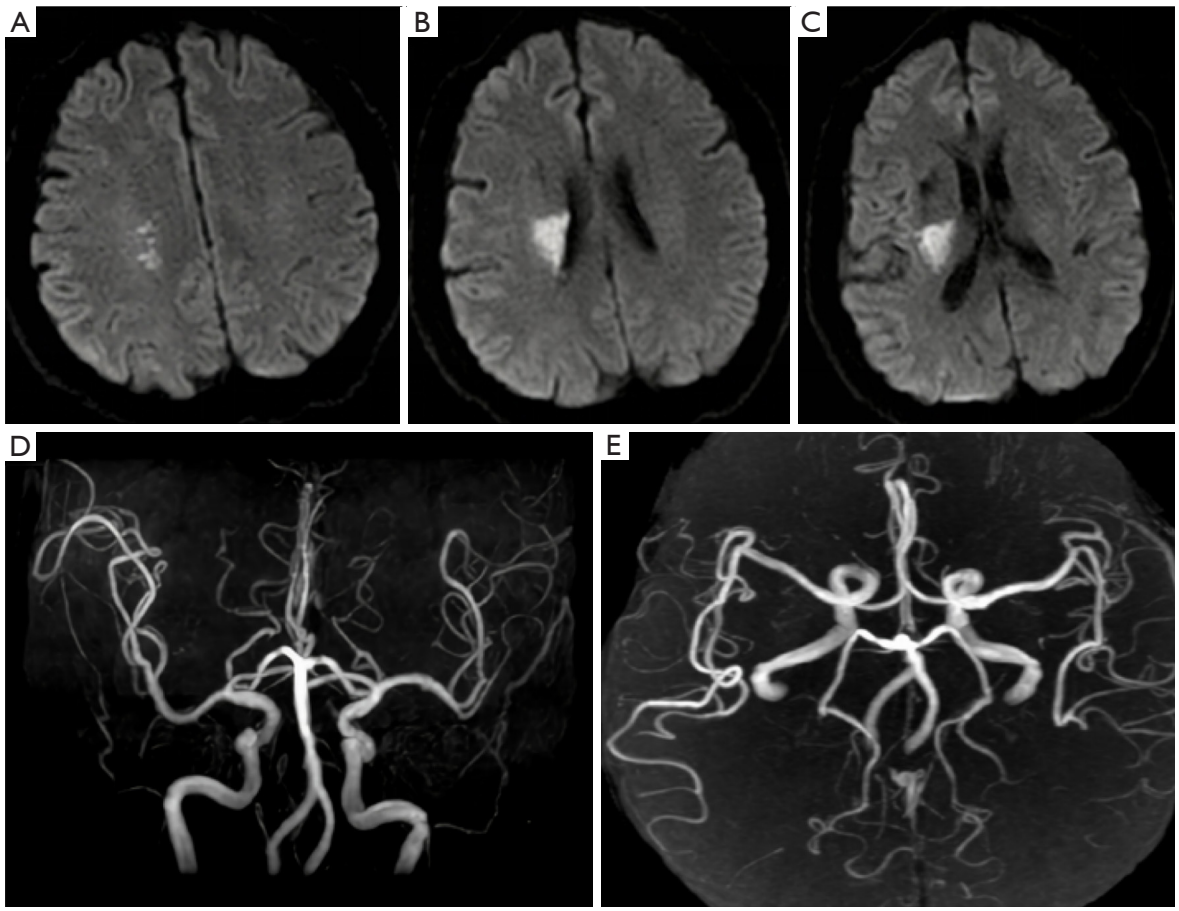

Figure 4 A 68-year-old, male patient with atrial fibrillation. (A-C) The DWI sequence showed multiple speckled and patchy diffusion restriction in the right frontoparietal and radial crown-basal ganglia regions. (D,E) MRA showed cerebral arteriosclerosis with no significant lumen stenosis or dilatation and slightly sparse distal branches of the L-MCA. DWI, diffusion-weighted imaging; MRA, magnetic resonance angiography; L-MCA, left-middle cerebral artery.

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Footnote

Reporting Checklist: The authors have completed the STROBE reporting checklist. Available at https://qims.amegroups.com/article/view/10.21037/qims-23-800/rc

Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at https://qims.amegroups.com/article/view/10.21037/qims-23-800/coif). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are have appropriately investigated and resolved. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved by the Ethics Committee of Shandong Provincial Hospital, and the requirement of individual consent for this retrospective analysis was waived.

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