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Original Article

Assessment of the reperfusion success using TIMI Frame score in cases with anterior myocardial infarction undergoing thrombus aspiration

Trombüs aspirasyonu yapılan akut anteriyor miyokard infaktüsünde reperfüzyon başarısının TIMI Frame sayımıyla değerlendirilmesi

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ABSTRACT

Aim: Achieving reperfusion is the key target in the treatment of myocardial infarction with acute ST elevation. In our study, we aimed to compare the improvement in coronary blood flow using corrected TIMI frame score (cTFC) in patients, who presented with acute anterior ST elevated myocardial infarction (AASTEMI), underwent primary percutaneous coronary intervention (PPCI) with manual thrombus aspiration (MTA) and those, who underwent PPCI alone.

Material and Methods: We included 30 patients with acute AASTEMI, who underwent PPCI with MTA and 60 patients, who underwent PPCI alone, between June 2009 and August 2013. Coronary angiography images were reviewed after the procedure to evaluate distal embolization, TIMI scores and the corrected TIMI frame scores in both groups. All-cause mortality and stent thrombosis were recorded at hospital admission. All-cause mortality, stent thrombosis, and hospitalization due to cardiac failure, occurring within a month of discharge, were investigated.

Results: The mean age was 56.50 ± 16.45 among patients undergoing thrombus aspiration; there were 22 males and 8 females. Among those who did not undergo MTA, the mean age was 56.57 ± 13.21; and there were 44 males and 16 females. The rate of previous myocardial infarction (MI) (23.3 % vs 6.6 %; p = 0.019) and history of percutaneous coronary intervention (PCI) (20.0 % vs 6.7 %, p = 0.040) was higher in patients, who underwent MTA. The mean TIMI frame score was 28.33 ± 7.24 and 26.68 ± 8.22, respectively in the patients, who underwent and did not undergo MTA; however, no statistically significant difference was detected (p = 0.389). Overall time to ischemia was longer in the groups of patients, who underwent MTA (8.23 ± 9.68 vs 3.68 ± 8.22 hours, p = 0.003). Three patients, who underwent MTA (10 %, p = 0.007) died before discharge and 1 patients (13.1 %, p = 0.003) died within a month. No cases of death were detected in the group of patients, who did not undergo MTA, in the hospital and within a month. There were no statistically significant differences between these two groups with respect to hospitalization due to cardiac failure and occurrence of stent thrombosis.

Conclusion: The use of MTA in AASTEMI did not have a favorable impact on reperfusion compared to not using MTA.

Keywords: Myocardial infarction, thrombus aspiration, acute anterior myocardial infarction, percutaneous coronary intervention

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ÖZ

Amaç: Akut ST yükselmeli miyokard enfarktüsü tedavisinde reperfüzyonun sağlanması temel hedeftir. Bizim çalışmamızda amacımız; akut anteriyor miyokard infarktüsü ile başvuran, manuel trombüs aspirasyonu ile primer perkütan koroner girişim yapılan ve yalnızca primer perkütan koroner girişim yapılan hastalarda, koroner kan akımındaki iyileşmeyi, düzeltilmiş TİMİ frame sayımı (dTFS) kullanarak kıyaslamaktır.

Gereç ve Yöntemler: Çalışmaya retrospektif olarak akut anteriyor miyokard in-farktüsü olup manuel trombüs aspirasyonu ile birlikte primer perkütan koroner giri-şim uygulanmış 30, yalnızca primer perkütan koroner girişim uygulanmış 60 hasta alındı. Gruplar yaş ve cinsiyet açısından eşleştirdi. Koroner anjiografi filmleri tekrar izlenerek her iki grubta distal embolizasyon, TİMİ skoru ve dTFS değerlendirildi. Hastane yatışı esnasında tüm nedenli ölümler, stent trombozu kaydedildi. Taburcu-luk sonrası bir ay içinde meydana gelen tüm nedenli ölümler, stent trombozu ve kalp yetersizliği nedenli yatışları incelendi.

Bulgular: Trombüs aspirasyonu yapılanların, ortalama yaşı 56.50±16.45. Tombüs aspirasyonu yapılmayanların ortalama yaşı 56.57±13.21 idi. Manuel trombüs aspi-rasyonu yapılan grupta dTFS ortalama 28.33±7.24, yapılmayan grupta ortala-ma 26,68±8.22, olarak tespit edildi. Ancak istastistiksel olarak fark tespit edilmedi (p=0.389). İşlem sonrası her iki grupta da EKG'de benzer oranlarda ST segment rezolüsyonu tespit edildi. Manuel trombüs aspirasyonu yapılan 3 hasta (%10, p= 0.007) taburculuk öncesi, 1 hasta (%13.1, p=0.003) bir ay içinde ölmüştür. Trombüs aspirasyonu yapılmayan grupta hastane içinde ve bir ay içinde ölüm izlenmemiştir. Gruplar arasında bir ay içinde kalp yetersizliği nedenli hastane yatışı ve stent trom-bozu görülme oranları açısından istastistiksel fark tespit edilmedi.

Sonuç: Çalışma grubumuzda akut anteriyor miyokard infarktüsünde manuel trom-büs aspirasyonun kullanılması, kullanılmamasına göre reperfüzyon üzerine olumlu etki göstermemiştir.

Anahtar Kelimeler: Miyokard infarktüsü, trombüs aspirasyonu, akut anteriyor miyokard infarktüsü, perkütan koroner girişim

Introduction

In case of acute myocardial infarction (AMI), a leading cause of morbidity and mortality worldwide, the best established treatment is rapid complete restoration and maintenance of the coronary flow [1, 2]. Since the objective is to provide and maintain coronary patency, MTA appears to be a low-cost, easily applicable method. However, data on routine use in AASTEMI is not sufficient. Therefore, we aimed to investigate whether there was any difference in achieving post-procedure coronary blood flow by using TIMI frame scores in patients, presenting to our center with AASTEMI, who underwent PPCI alone and those who underwent PCI following MTA.

Material and Methods

Patient population demographics

The study sample consists of patients with AASTEMI (30), who were administered MTA and PPCI by different operators from our center and age- and sex-matched AASTEMI patients, who only underwent PPCI (60) between June 2009 and August 2013 at the Turkiye Yuksek Ihtisas Hospital. The demographics of patients included in the study were obtained from by screening of files and one to one telephone calls. Risk factors such as age, sex, diabetes mellitus (DM), hypertension, hyperlipidemia and smoking were recorded. Those with a systolic blood pressure > 140 mmHg, a diastolic blood pressure > 90 mmHg or those with a history of antihypertensive use were considered to be hypertensive patients. Those with a fasting LDL level > 130 mg/dL or history of statin use were considered to be hypercholesterolemic and patients with a fasting blood sugar > 126 mg/dL and those who were on treatment for established DM were considered to be diabetics. Smoking was classified as smoking patients and those with no history of smoking. Height and weight were recorded to calculate the body mass index (BMI). Patients with a TIMI flow of 0 or I following MTA or PPCI, and patients, who used thrombolytics before the procedure, who underwent an unsuccessful PPCI or were observed to have > 50 % left main coronary lesion, developed cardiogenic shock, were detected to have spontaneous recanalization by angiography, met the criteria of left ventricular hypertrophy on ECG as per Sokolow Lyon criteria, or in whom ECG could not be assessed accurately due to left branch block and patients, who had a break in post-procedure aspirin and / or clopidogrel use for any reason were excluded from the study.

Coronary angiography and thrombus aspiration

Coronary angiography was performed through the femoral artery, using the standard Judkins technique. Iopromide (Ultravist 370/100 mL) was used as the contrast agent and 6-8 contrast materials were manually injected for each posture. Coronary arteries were displayed on the right and left oblique planes, at cranial and caudal angles at 25 frames per second (25 fps) and transferred to the CD using DICOM software. Patients were given aspirin (300 mg), heparin (50000 U, intravenous route) and clopidogrel (600 mg) before being transferred to the catheter room and depending on their weight, they were given additional heparin at 100 U/kg in the catheter room.

Manual, double-lumen Export Aspiration Catheter was used for performing thrombus aspiration and these patients were administered coronary stent as required. Those, who did not undergo MTA, were only administered PPCI (balloon and/or stent). Recanalization of the relevant artery was confirmed by angiography following PPCI. A control ECG was performed at the 90th minute in patients, who achieved TIMI II-III flow. Use of glycoprotein IIb / IIIa receptor inhibitor was left to the discretion of the operator. Tirofiban was used as the glycoprotein IIb / IIIa receptor inhibitor.

ST segment resolution measurement

Without the presence of left ventricular hypertrophy (LVH) and left branch bundle block (LBBB), the diagnosis of AASTEMI was established by detection of ≥ 1 mm (0.1 mV) new and extended (> 20 minutes) ST elevation on DI, aVL, V1-6 on at least two consecutive derivations starting from the J point on V2-V3 derivations, which was ≥ 2.5 mm (0.25 mV) in males below 40 years of age and ≥ 2 mm (0.2 mV) in males above 40 years of age, and ≥1.5 (0.15 mV) in females [3]. Measurements were obtained from ECG samples, recorded right before PPCI and at 90 minutes after TIMI II-III flow was achieved. ST segment elevation was measured in millimeters. The difference between the two measurements was expressed in percentage and was assessed as the ST segment resolution (STR). STR was divided into two groups as below and above 50 %.

TIMI frame score assessment

Corrected TIMI frame count method was used for quantitative measurement of coronary blood flow as previously described [4]. After administering an opaque material to determine the frame score, the point when the contrast material touched the two sides of the artery and started moving forward was measured as the starting point while the point when the contrast material reached the distal branching point for left anterior descending artery, called moustache, was measured as the final point.

Endpoints

The primary endpoint was the TIMI frame score. The secondary endpoints included in-hospital mortality, distal embolization, stent thrombosis and 30-day mortality, and hospitalization due to stent thrombosis and cardiac failure. Informed consent was obtained from all patients and the study was approved by the local Ethics Committee.

Statistical analysis

SPSS for Windows 11.5 packaged software was used for statistical assessment of data. Chi-square test and Fisher's exact test for comparing categorical data, Student's t test for assessing continuous data with normal distribution and Mann-Whitney U tests were used for data without normal distribution. As the descriptive values, number and percentages for categorical data and arithmetic mean ± standard deviations for continuous data were given. The limit of statistical significance was set at 0.05.

Results

There were 30 patients with AASTEMI, who underwent MTA followed by PPCI and age- and sex-matched 60 patients, who underwent PPCI only.

There were no statistically significant differences between the two groups with respect to age, sex, BMI, smoking, familial history, DM, hypertension, coronary artery bypass grafting surgery (CABG) history. In the group, who received MTA, the rate of previous myocardial infarction (23.3 %; vs. 6.6 %, p = 0.019) and history of percutaneous coronary intervention (PCI) (20.0 % vs. 6.7 %, p = 0.040) was higher. Hyperlipidemia was detected at a higher rate in the group, who did not undergo MTA (68.3 % v.s. 40.0 %, p = 0.005). Other demographics were similar between groups (Table 1).

Table 1. Demographics of patients with or without MTA

	Thrombus aspiration				p
	Performed (N=30)		Not performed (N = 60)		
age (years) (mean ± SD)	56.50 ± 16.45		56.57 ± 13.21		0.832
Body mass index (kg/m2) (mean±SD)	27.26 ± 4.23		27.30 ± 2.36		0.217
Sex (M /F)	22 / 8		44 / 16		0.501
Smoking (%)	18	60.0 %	40	66.9 %	0.211
Family history (%)	8	26.7 %	22	36.6 %	0.299
Diabetes Mellitus (%)	11	36.7 %	14	23.3 %	0.171
Hypertension (%)	13	43.3 %	21	35.0 %	0.412
Hyperlipidemia (%)	12	40.0 %	41	68.3 %	0.005
Previous MI (%)	7	23.3 %	4	6.6 %	0.019
Percutaneous coronary intervention history (%)	6	20. 0 %	4	6.7 %	0.049
Coronary artery bypass history (%)	1	3.3 %	0	0.0 %	0.200

The results for the laboratory variables of the study population by each group were detected to be similar, except the platelet count and total cholesterol. The group of patients, who underwent MTA, was observed to have a statistically significantly higher mean platelet level and total cholesterol (Table 2). The two groups did not have a statistically significant difference with respect to the number of diseased vessels, and pre- and post-procedure TIMI flow. The mean TIMI frame score was 28.33 ± 7.24 and 26.68 ±8.22, respectively in the group of patients, who underwent and did not undergo MTA Figure1. There was no statistical difference (Table 3). The overall time to ischemia was longer in the group of patients, who received MTA (8.23 ± 9.68 hours vs. 3.68 ± 8.22 hours, p = 0.003). There was no statistical difference between the two groups with respect to application of pre-dilatation during the procedure, the size of the stents used and the stent implantation pressure (Table 5). After the procedure, STR was detected at similar

rates on ECG in both groups. Three patients (10 %, p = 0.007), who underwent MTA, died before being discharged and one patient (13.1 %, p = 0.003) died within one month. There was no in-hospital mortality or deaths within one month in the patients, who did not undergo MTA. There were no statistically significant differences between these two groups with respect to hospitalization due to cardiac failure and occurrence of stent thrombosis (Table 6).

Table 2. Hemodynamic and laboratory characteristics of the patients with or without MTA

	Thrombus Aspiration		P
	Performed (N = 30)	Not performed (N = 60)	
	Mean ± SD	Mean ± SD	
Systolic blood pressure (mmHg)	119.67 ± 25.40	118.35 ± 23.99	0.801
Diastolic blood pressure (mmHg)	72.97 ± 12.81	72.68 ± 14.11	0.923
Heart rate (beat/minute)	83.90 ± 12.12	84.12 ± 17.40	0.832
Hemoglobin (g/dL)	13.22 ± 1.69	13.68 ± 2.88	0.055
Platelet (103/mm3)	277.90 ± 90.34	230.11 ± 63.77	0.003
White spheres (103/mm3)	12.90 ± 4.28	12.78 ± 4.91	0.324
Neutrophils (%)	78.33 ± 10.75	76.31 ± 12.66	0.235
Glucose (mg/dL)	178.63 ± 146.74	141.63 ± 76.33	0.154
Urea (mg/dL)	38.77 ± 20.46	35.23 ± 11.45	0302
Creatinine(mg/dL)	0.93 ± 0.31	0.90 ± 0.39	0.621
Potassium (mmol/L)	4.20 ± 0.32	4.21 ± 033	0.899
Total cholesterol (mg/dL)	167.43 ± 36.31	155.42 ± 45.01	0.032
HDL (mg/dL)	39.00 ± 11.19	40.01 ± 11.24	0.502
LDL (mg/dL)	102.30 ± 30.45	100.21±36.89	0.701
TG (mg/dL)	131.73 ± 66.23	134.14 ± 105.36	0.825

HDL: High Density lipoprotein, LDL: Low Density Lipoprotein TG: Triglyceride

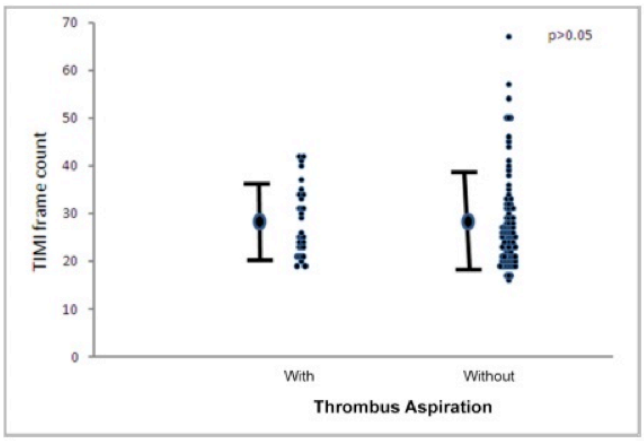

Figure 1. TIMI Frame scores in group of patients with or without MTA

Table 3. Angiographic characteristics of patients with or without MTA

	Thrombus Aspiration		P
	Performed (N = 30)	Not performed (N = 60)	
Number of diseased vessels	Median = 3 (min.- max. ; 1-3)	Median = 2 (min.- max. : 1-3)	0.110
Pre-procedure TIMI flow	Median = 0 (min.- max. ; 0-1)	Median = 0 (min.- max. : 0-1)	0.354
Post-procedure TIMI flow	Median = 3 (min.- max. ; 1-3)	Median = 3 (min.- max. : 2-3)	0.210
TIMI Frame Score	28.33 ± 7.24	26.68 ± 8.22	0.389

Table 4. Time to total ischemia in patients with or without MTA

	Thrombus Aspiration		P
	Performed (N = 30)	Not performed (N = 60)	
	Mean ± SD	Mean ± SD	
Time to total ischemia (hours)	8.23 ± 9.68	3.68 ± 8.22	0.003

Table 5. Comparison of the procedures in patient groups with or without MTA

	Thrombus aspiration				P
	Performed (N = 30)		Not performed (N = 60)		
Predilatation (N)	19	63.3 %	33	55.0 %	0.410
Stentdiameter (mean ±SD) (mm)	2.92 ± 1.09		3.18 ± 0.29		0.312
Stent length (mean±SD) (mm)	18.15 ± 5.59		18.78 ± 5.57		0.821
Stentimplantation pressure (mean±SD) (mmHg)	13.47 ± 4.97		13.98 ± 3.30		0.238

Table 6. Clinical monitoring characteristics of patients with or without MTA

	Thrombus Aspiration				P
	Performed (N = 30)		Not performed (N = 30)		
ST segment resolution	21	70.0 %	71	58.3 %	0.306
In-hospital mortality	3	10.0 %	0	0.0 %	0.007
1-month hospitalization for cardiac failure	1	3.3 %	4	6.7 %	0.492
1-month all-cause mortality	4	13.1 %	0	0.0 %	0. 048
1-month stent thrombosis	2	6.7 %	10	16.6 %	0.212

Discussion

The most significant therapeutic approach in acute ST elevated myocardial infarction (ASTEMI) is preservation of the myocardial viability and function by opening the occluded vessel. Reduced coronary blood flow is associated with cardiac failure and death, therefore the aim is to achieve normal coronary blood flow.

During the reperfusion treatment process, starting with the clear mortality benefit, provided with fibrinolytic treatment, complete reperfusion is achieved only in 50-60% of the patients [5]. Today, reperfusion treatment has taken on another dimension along with new anti-platelet drugs, PPCI-performing sites and technologic advances. One of these important advances is the initiated use of thrombus aspiration devices in reperfusion procedures. Coronary artery thrombus aspiration is an easy, fast and relatively low-cost method that assists PCI. In the recent years, some publications on the use of MTA devices as an additional treatment method in PPCI cases have reported promising results. While it is not a universal finding, it is considered to potentially improve blood flow and ST segment resolution. However despite its morbidity and mortality benefit in PPCI, the clinical benefit of thrombus aspiration is not clear due to different results from studies on thrombus aspiration. Therefore we investigated the efficacy of PPCI in achieving and maintaining vascular patency. To this end, we measured the TIMI frame score to evaluate whether there was a difference in achievement of coronary blood flow after the procedure in patients, presenting with AASTEMI and who underwent MTA followed by PPCI and who underwent PPCI alone. The mean TIMI frame score was 28,33 ± 7,24 and 26,68 ± 8,22 respectively in the patients, who did and did not undergo MTA; however no statistically significant difference was detected. The two methods showed a similar success in improving the blood flow.

Following TAPAS (Thrombus Aspiration During Percutaneous Coronary Intervention in Acute Myocardial Infarction Study), a large, randomized, controlled study, published in 2010 [6], use of MTA in ASTEMI was presented as a class IIa recommendation in The American College of Cardiology Foundation/American Heart Association (ACCF\AHA) ST elevation myocardial infarction guideline [7]. In this study, a total of 1071 cases were randomized into two groups, including stenting only or aspiration thrombectomy followed by stenting, and the results investigated. Aspiration was successfully performed in 90 % of the patients and in 72 %, thrombus or atheroma was excised. While the group of patients undergoing aspiration had a significantly better myocardial staining score and STR, these favorable effects on myocardial perfusion also resulted in favorable outcomes in one-year clinical monitoring. During the one-year monitoring period, cardiac mortality was 3.6 % to 6.7 % ($p = 0.02$) and cardiac mortality or myocardial infarction (MI) was reported at 5.6 % to 9.9 % ($p = 0.008$) [6].

In another meta-analysis of 9 randomized studies, a lower level of distal embolization, better staining scores were obtained with thrombus aspiration and a better 30-day mortality rate was observed with STR [8].

In PPCI, aspiration thrombectomy is considered to have two types of potential benefit. The primary benefit is thought to be achievement of a better myocardial perfusion by prevention of the distal embolization. Secondarily, the recent publications have shown that thrombus aspiration reduces the rates of stent thrombosis. Particularly in ASTEMI patients with thrombus load, this risk is known to be increased if drug-eluting stent implantation is performed [9]. Reduction of the thrombus extent would reduce late stent malposition, thereby leading to a better-functioning stent and ensuring a more optimal stent strut distribution and decreasing late thrombosis risk in the long term. Another published study, TASTE (Thrombus Aspiration during ST-Segment Elevation Myocardial Infarction) included 7244 patients from 31 centers and 3621 were randomized to the thrombus aspiration arm and 3623 were randomized to the control arm. During the 30-day follow-up, all-cause mortality, recurrent MI and stent thrombosis were similar between the two arms. Other clinical endpoints were also the same. This study was approximately 10-fold larger than the TAPAS study [10]. On the other hand, 30-day results were used in the TASTE study, and thus, clinical benefit of thrombus aspiration may become clearer after a long period of follow-up. In our study, the rate of patients with DM (36.7 %) was higher in the MTA group relative to the non-MTA group (23.3 %) even if the difference was not statistically significant. On the other hand, total ischemia time was longer in the MTA group compared to the non-MTA group ($p = 0.003$). The higher rates of diabetic patients, patients who presented late and had a high angiographic coronary artery thrombus load may have affected the success of the procedure.

The rate of previous MI (6.6 % versus 22.9 %; $p = 0.019$) and history of percutaneous coronary intervention was (6.7 % versus 20.0 %, $p = 0.040$) was higher in patients, who underwent thrombus aspiration. The presence of patients with a higher-risk and a higher comorbidity in the MTA group may have affected the results.

In a meta-analysis of 13 randomized studies on manual thrombectomy, the myocardial staining score and STR were significantly better while mortality rates were lower [11].

As for our study, we detected similar rates of STR on ECG after the procedure in both groups. In the MTA group, 3 patients

died before being discharges (10 %, p = 0.007) and one patient (13.1 %, p = 0.003) died within a month. In the non-MTA group, no in-hospital mortality or deaths within a month were observed. Although the sample size is not adequate to assess as mortality data, mortality rates were statistically higher in the MTA group.

Despite all these favorable results from studies and meta-analyses, the ability to achieve the same benefit in all patients with ASTEMI is still controversial. It may be appropriate to think that particularly patients with abundant thrombi would benefit more from thrombus aspiration. There are other large-scale ongoing studies on the subject. Use of thrombus aspiration does not appear to be rational until these studies are completed.

Limitations to the study

The number of cases that received MTA in the study was small. However, the study includes all AASTEMI patients, who underwent MTA and met the study criteria between June 2009 and August 2013. In this retrospective study, invasive intervention was not performed by a single physician. The decision to perform MTA was made by the operator performing the procedure depending on the thrombus load of the coronary bed. Even if there are some angiographic clues, it is not always easy to detect the presence of thrombus. Generally, thrombi on the coronary bed may be observed as filling defects in different forms, which are mobile or immobile on angiograms of patients, who have shown a recent clinical deterioration. Severity of the thrombus content may be mostly understood after passing through with a guidewire and even after performing a pre-dilatation and displaying the distal vascular bed. However in certain cases, this procedure coincides with distal embolization. Another limitation was the fact that the patients undergoing MTA were clinically more morbid. Additionally, as can be understood from the small number of cases, the little experience of the operator may have affected the results.

Conclusion

In our study, the use of MTA in AASTEMI did not have a favorable impact on reperfusion compared to not using MTA. The high extent of thrombus that can be observed during coronary artery interventions may affect the success of intervention and long-term results unfavorably. Today, despite the presence of data in support of use particularly in case of lesions with intense thrombi, routine use in all cases is not recommended.

Declaration of conflicting interests

The author declared no conflicts of interest with respect to the authorship and/or publication of this article.

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