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Prevalence of aspirin and clopidogrel resistance in neurovascular stenting: a single-center experience

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ABSTRACT

Objectives: The objective of this study was to determine the frequency of aspirin and clopidogrel resistance of patients undergoing neurovascular stenting procedure in the interventional radiology unit.

Methods: The Multiplate® Analyzer (Roche Diagnostics, Germany) test data of 250 patients who underwent carotid or intracranial artery stenting due to atherosclerotic stenosis or treatment of intracranial aneurysms between 2013-2017 in the Interventional Radiology Unit of our hospital were evaluated retrospectively to detect the aspirin and clopidogrel resistance. Aspirin or clopidogrel resistance defined as the higher AUC value than 40U and 46U, respectively. The patients who did not have a result of the Multiplate® test; had anemia, known coagulation disorder or thrombocytopenia were excluded.

Results: Among the 172 patients who met the inclusion criteria, 59 (34.3%) were those who had an intracranial stent during aneurysm treatment, and 113 (65.7%) had carotid stenting due to atherosclerotic stenosis. The prevalence of aspirin resistance was 9.4% (16/170) whereas that of clopidogrel resistance was 23.8% (41/172). Among the patients with atherosclerotic stenosis, aspirin resistance accounting for 3.6%, and clopidogrel resistance was 23.0%. Furthermore, the resistance in the patients with stent-assisted coiling for aneurysm treatment was 20.7% for aspirin and 25.4% for clopidogrel.

Conclusions: In our study, the prevalence of aspirin resistance was found 9.4% and clopidogrel resistance 23.8% in patients who had neurovascular stenting. The effect of this condition on clinical outcomes in these patients should be investigated by randomized controlled trials.

Keywords: Neurovascular stenting, aspirin resistance, clopidogrel resistance, multiplate test, antiplatelet resistance

Dual antiplatelet treatment with aspirin (acetylsalicylic acid) and clopidogrel has been readily accepted regiment of antithrombotic therapy in patients undergoing neurovascular stenting [1]. Although these antithrombotics have been used in patients as premedication and after neurovascular stenting procedure, thromboembolic complications have still been encountered during or/and after the procedure [2].

Insufficient in vivo platelet inhibition with aspirin and clopidogrel have been accused of thromboembolic complications theoretically. If inadequate platelet inhibition is demonstrated with a laboratory test, the terms 'resistance to aspirin or clopidogrel', 'low response to aspirin-clopidogrel', or 'nonresponse to aspirin-clopidogrel' have been used. In vitro laboratory tests detecting platelet function, namely Multiplate®,

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VerifyNow®, Light Transmission Aggregometry (LTA), PFA-100 (Platelet Function Assay), VASP (vasodilator-stimulated phosphoprotein), have been used excessively among patients with cardiovascular intervention in order to indicate patients with inadequate platelet inhibition [3]. This trend has been adopted in the field of neurovascular intervention by some centres and the Multiplate® test has been used in our neurovascular interventional unit for this purpose.

Providing antiplatelet drug resistance could be determined before neurovascular stenting, antiplatelet dosage and combination might be adjusted on an individual basis to prevent new thromboembolic events [4]. Therefore, it might be important to know the inadequate response to aspirin and clopidogrel in patients who will have neurovascular stent-placement procedures. In this study, we aimed to detect the frequency of aspirin and clopidogrel resistance in patients undergoing neurovascular stenting in the interventional radiology unit of our hospital.

METHODS

Patient Group

Patients who underwent elective intracranial or extracranial stent placement with different indications at the Interventional Radiology Unit of our (the name hidden for blinded review) University, Faculty of Medicine, Department of Radiology between January 1, 2013 and January 31, 2017 were assessed.

The patients who did not receive aspirin or clopidogrel for any reason or did not have a complete result of the resistance test; had anemia (Hg level < 8 g/dl), known coagulation disorder or thrombocytopenia (< 50.000 /m^3), polycythemia, leukopenia (leukocytes < 4.000 /mm), bone marrow disease or blood transfusion were excluded. In addition, those whom taken blood samples could not be processed between 30 minutes and 3 hours were not included.

Records of patients in the study were retrospectively reviewed and the data were collected including age, sex, and presence of concomitant diseases such as hypertension, diabetes, cerebrovascular event (CVO), coronary artery disease (CAD), hypercholesterolemia, chronic kidney disease (CKD) and chronic liver disease. Moreover, results of the fasting blood samples obtained on the day before or on the day of the procedure were evaluated to note blood glucose, creatinine, hemoglobin, platelet, and leukocyte counts.

Routine screening for clinically silent ischemic strokes with diffusion-weighted imaging was not performed. Post-procedural images of patients (unenhanced computed tomography or magnetic resonance imaging) were retrospectively examined for possible new ischemic findings by comparison with pre-procedural imaging.

Medication of Patients

Patients scheduled for elective neurovascular stent placement received 100 mg aspirin and 75 mg clopidogrel per day for 7 days prior to the procedure normally. If there were less than 7 days to the procedure, 300 mg clopidogrel and aspirin per day were given for 3 days and then continued with 100 mg aspirin and 75 mg clopidogrel daily. None of our patients received 600 mg clopidogrel as a loading dose just before the day of the procedure.

If the clopidogrel resistance was demonstrated by Multiplate® test, the premedication was adjusted as 500 mg of ticlopidine and 100 mg of aspirin for 7 days before the procedure. In case of still antiplatelet resistance presence, prasugrel 10 mg per day alone was given 7 days before the procedure.

Multiplate® test

Venous blood samples were collected 24 hours before the procedure from the peripheral antecubital vein by nurses. Blood samples were filled into hirudin filled tubes after which they were sent to the hematology laboratory within 30 minutes. Platelet function tests were studied with the Multiplate® analysis system (Fig. 1). Blood samples were stored at room temperature for 30 minutes. Platelet aggregation was evaluated using the impedance method within 30-180 minutes in total after samples were collected. 300 microliters of the blood sample were taken and were diluted again with 300 microliters of 0.9% saline at room temperature. 20 microliters ADP or ASP test agents were added into these sample after 3 minutes incubation period.

The results were obtained by calculating the area under the curve (AUC) at the end of the 6 minute evaluation period. The recommended range for AUC values is 71-115U for aspirin and 57-113U for clopidogrel. Aspirin Multiplate® test results above 40U

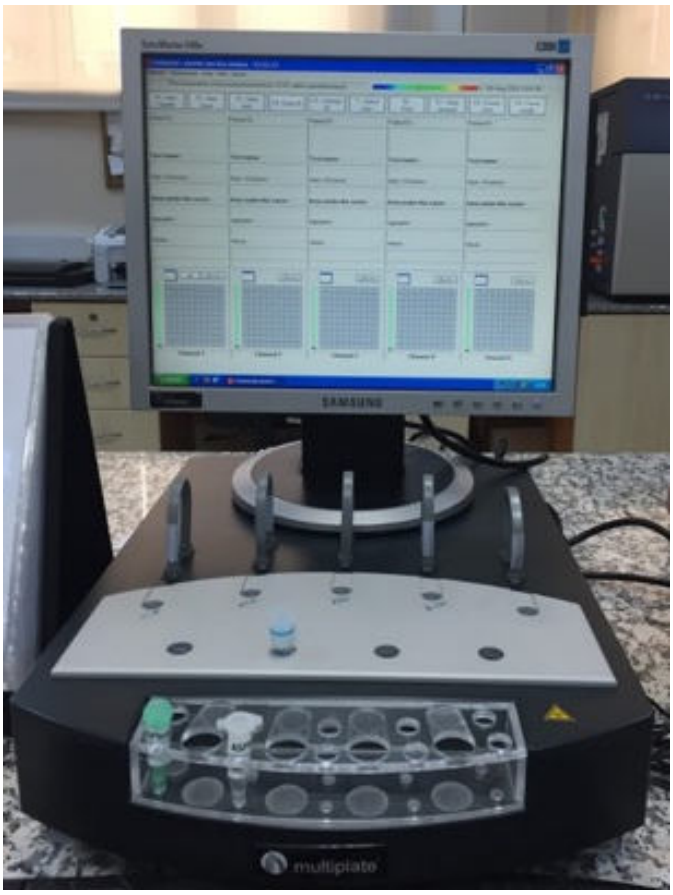

Fig. 1. Multiplate Test Machine. Multiplate test machine in our hospital is located in Hematology laboratary; however, it is possible to be situated and utilized it with a trained staff in interventional radiology units.

were recorded as the group showing aspirin resistance while for clopidogrel, those with a result above 46U were recorded as with clopidogrel resistance. Follow-up platelet-activity testing was not performed after the procedure.

Statistical Analysis

SSPS version 23.0 was used for statistical analysis. The patients were divided into two groups as stenting due to atherosclerotic stenosis and stent-assisted coil embolization for aneurysm treatment. For these two groups, separately, and all patients are searched for aspirin and clopidogrel resistance. The two groups were compared in terms of the frequency of resistance. Clinical characteristics were also compared between these two groups, as well as the resistant versus non-resistant groups. The independent samples t-test, Mann Whitney U test, and Chi square tests were used to determine the correlations between the variables. A p value of < 0.05 was considered statistically significant. The study was approved by the ethics committee of our hospital.

RESULTS

In this study, 250 patients who underwent neurovascular stenting in the Interventional Radiology Unit of our hospital between 2013 and 2017 were identified. 78 of these were excluded since 74 of them those whom could not be reached the complete Multiplate® test results, 2 of them had severe anemia and the remaining 2 had severe thrombocytopenia. 57 (33.1%) of the patients were female while 115 (66.9%) were male. The mean age was 65.6 (20-92) years. Of the remaining 172 patients, 59 (34.3%) were those the intracranial stents were implanted during aneurysm embolization, and 113 (65.7%) were the ones who had stenting for the treatment of atherosclerotic stenosis. Flow diverter devices were used in 35 (20.3%) patients who had stent placement during aneurysm treatment. The prevalance of aspirin resistance was 9.4% (16/170) in all patients whereas that of clopidogrel was 23.8% (41/172). There were 9 (5%) patients with both aspirin and clopidogrel resistance.

When the group with aspirin resistance was compared with the group without resistance, a significant difference was found between the ages ($p = 0.005$). The mean age was 57.4 ± 12.2 years in the resistant group while it was 66.6 ± 12.8 years in the nonresistant group. There were no significant difference between resistant and non-resistant groups in terms of concomitant diseases; diabetes, hypertension, coronary artery disease, and dyslipidemia. Moreover, no significant difference was found between the two groups concerning thromboembolic findings in the cranial MR or CT (Table 1).

When the group with clopidogrel resistance and the one without resistance were compared; the presence of diabetes was found 63.4% in the resistant group, while it was 26.0% in the non-resistant group ($p < 0.001$). There was no significant difference between the two groups in other parameters (Table 2).

Aspirin resistance was 3.6% and clopidogrel resistance was 23.0% in the stent-implanted group due to atherosclerotic stenosis, whereas the resistance in the stent-assisted aneurysm treatment group was

Table 1. Comparison between the group with aspirin resistance and without resistance

Parameter	Group with Aspirin resistance (n = 16)	Group without Aspirin resistance (n = 154)	*p* value
Age (years)	57.38 ± 12.2	66.61 ± 12.8	**0.005**
Gender (female)	43.8%	31.2%	0.457
Diabetus mellitus	37.5%	33.8%	0.982
Hypertension	56.3%	63.0%	0.796
Coronary arterial disease	25.0%	26.0%	1.000
Dyslipidaemia	18.8%	38.3%	0.203
Chronic kidney disease	0.0%	3.2%	1.000
Radiologic thromboembolic findings	20.0%	32.2%	0.720
Creatinine (mg/dl)	0.77 ± 0.2	0.89 ± 0.25	0.026
Glucose (mg/dl)	144.9 ± 65.2	132.5 ± 91.7	0.187
Leukocyte ($\times 10^9$)	8.4 ± 3.2	8.6 ± 3.2	0.839
Platelet ($\times 10^9$)	225.6 ± 72.8	229.2 ± 71.1	0.892
Hemoglobin (g/dl)	12.8 ± 1.3	12.9 ± 1.6	0.764

Data are shown as mean ± standard deviation or n (%)

Table 2. Comparison between the group with clopidogrel resistance and without resistance

Parameter	Group with Clopidogrel resistance (n = 41)	Group without Clopidogrel resistance (n = 131)	*p* value
Age (years	65.9 ± 11.4	65.60 ± 13.4	0.960
Gender (female)	36.6%	32.1%	0.729
Diabetus mellitus	63.4%	26.0%	**< 0.001**
Hypertension	68.3%	61.1%	0.516
Coronary arterial disease	25.0%	26.0%	0.259
Dyslipidaemia	41.5%	34.4%	0.521
Chronic kidney disease	4.9%	2.3%	0.594
Radiologic thromboembolic findings	20.0%	34.7%	0.261
Creatinine (mg/dl)	0.88 ± 0.28	0.88 ± 0.24	0.934
Glucose (mg/dl)	128.4 ± 51.4	135.5 ± 97.9	0.994
Leukocyte ($\times 10^9$)	8.5 ± 3	8.5 ± 3.2	0.872
Platelet ($\times 10^9$)	238 ± 53.6	225 ± 75.6	0.118
Hemoglobin (g/dl)	12.6 ± 1.5	12.9 ± 1.5	0.237

Data are shown as mean ± standard deviation or n (%)

Table 3. The Aspirin and Clopidogrel resistance literature among patients with neurovascular procedures

Author and year	Number of patients	Procedure	Antiplatelet treatment	Antiplatelet Resistance test	Test Cut-off value	Prevalence of Aspirin Resistance	Prevalence of Clopidogrel Resistance
Lee *et al.* 2008	98	Stent placement (Intracranial aneurysm treatment or intra-extracranial artery stenosis)	Clp 300 mg loading dose followed by 75 mg Clp daily +325 mg Asp (5-10 days before)	VerifyNow	ARU ≥550, P2Y12 % İnhibition ≤40%	2.1%	42.9%
Müller-Schunk *et al.* 2008	50	Stent placement (intra-extracranial artery stenosis)	Asp 100 mg+ 300 mg Clp loading dose 12 hours before procedure or if there were more than 48 hours to procedure75 mg Clp daily	Multiplate	>52 ARU		28%
Prabhakaran *et al.* 2008	76	Stent placement (Intracranial aneurysm treatment or intra-extracranial artery stenosis)	Only Asp, Only Clp or Asp + Clp (1week before procedure)	VerifyNow	ARU ≥550, P2Y12 % İnhibition ≤40%	4.2%	50.9%
Reavey-Cantwell *et al.* 2009	81	Aneurysm embolization with or without stent placement or stent placement for intra-extracranial artery stenosis	Asp 325 mg + Clp 75 mg daily (7 days before)	PFA-100	PFA1 >209 or if PFA1 between 189-210 PFA2 >126	21%	
Dal-Sung Ryu *et al.* 2010	53	Coil embolization of aneurysm or intracranial stent placement or both	100 mg Asp + 75 mg Clp daily (at least 3 days before)	VerifyNow	ARU≥550 P2Y12 % inhibition≤40%	17%	62.3%
Pandya *et al.* 2010	216	Aneurysm embolization and stent placement (Intracranial aneurysm treatment or intra-extracranial artery stenosis)	Asp 81 mg + Clp 75 mg daily (if there is 7 days before procedure) or Clp 300-600 mg + Asp 325 mg loading dose (just before the procedure)	VerifyNow	ARU≥550 P2Y12 % inhibition≤50%	12%	34%
Drazin *et al.* 2011	52	Stent placement (Intracranial aneurysm treatment or intra-extracranial artery stenosis)	81 mg Aspirin+600 mg Clp (12 hours before the procedure) followed by 75 mg Clp + 81 mg Asp daily (if resistance shown 300 mg or 600 mg loading dose of Clp)	VerifyNow	ARU >550, P2Y12 % İnhibition <20%	13.5%	36.5%
Koerner *et al.* 2012	44	Stent placement (intra-extracranial artery percutan transluminal angioplasty)	Asp 100 mg + Clp 75 mg (at least 3 days before) or Clp 300 mg + Asp 500 mg loading dose (just before the procedure)	Multiplate	> 468 ARU		25%
Delgado Almandoz *et al.* 2013	44	Aneurysm treatment with Pipeline stent placement	Asp 325 mg+ Clp 75 mg daily	VerifyNow	PRU >200		26.2%
Fifi *et al.* 2013	96	Stent placement (Intracranial aneurysm treatment or intra-extracranial artery stenosis)	Asp 81 mg +75 mg Clp daily (5 days before) or 600 mg Clp loading dose in emergency cases)	VerifyNow	ARU ≥ 550 P2Y12 % inhibition ≤20%	5.2%	36.5%
Heller *et al.* 2013	25	Aneurysm treatment with Pipeline stent placement	Asp (325 or 81 mg) and Clp 75 mg daily (7 days before)	LTA	ASA maximum platelet aggregation >20%, CLP MPA >60%	16%	4%
Nordeen *et al.* 2013	81	Stent placement (Intracranial aneurysm treatment or intra-extracranial artery stenosis)	Asp 325 mg +75 mg Clp daily (5-7 days before) (600 mg Clp and 650 mg Asp loading dose in emergency cases)	VerifyNow	P2Y12 % inhibition <20%		21%
Kashiwazaki *et al.* 2014	66	Stent placement (Intracranial aneurysm treatment or intra-extracranial artery stenosis)	Asp 100 mg+ Clp 75 mg daily (14 days before) or Clp 300 mg+ Asp 500 mg loading dose(just before the procedure)	VerifyNow	P2Y12 % inhibition ≤26%		28.8%
Oran *et al.* 2015	68	Aneurysm treatment with flow diverter devices	Asp 300 mg+ Clp 600 mg loading dose (8-12 hours before)	Multiplate	Asp AUC >500, CLP AUC >468		25%
Hwang *et al.* 2015	228	The treatment of unruptured aneurysm with coil embolization	Asp 100 mg +75 mg Clp daily (5 days before) If resistance shown Asp 300 mg+ 200 mg cilastazol	VerifyNow	ARU ≥550 PRU ≥213	Resistance in general 55.3%	Resistance in general 55.3%
Tan et al. 2015	74	Aneurysm treatment with Pipeline stent placement	Asp 325 mg +75 mg Clp daily (5 day before) or Clp 600 mg, Asp 325 mg loading dose (2 hours before)	VerifyNow	PRU >208		52.7%
Wong *et al.* 2015	32	Stent placement (Intracranial aneurysm treatment or intra-extracranial artery stenosis)	Asp 325 mg +75 mg Clp daily (7 days before)	VerifyNow	PRU 120-180 normal		53.1%
Flechtenmacher *et al.* 2015	97	Stent placement (Intracranial aneurysm treatment or intra-extracranial artery stenosis)	Asp 100 mg +75 mg Clp daily (5 days before) or Clp 600 mg loading dose (1 day before)	LTA VerifyNow Multiplate	>40% PRU>236 ARU>40 U		47.6% 50.5% 35.9%
Asai *et al.* 2015	189	Aneurysm embolization with or without stent placement	Asp and Clp daily (5-7 days before)	VerifyNow	PRU ≥ 230	5.8%	34.9%
Kim *et al.* 2016	338	The treatment of unruptured aneurysms with coil embolization (with or without stent placement)	Asp 100 mg +75 mg Clp daily (7 days before)	VerifyNow	ARU ≥550 PRU ≥240	9.5%	31.1%
Song *et al.* 2017	99	The treatment of unruptured aneurysms with stent-assisted coil embolization	100 mg asp+75 mg Clp daily (5-7 days before) or 300mg asp+ 600 mg Clp loading dose (on the procedure day)	VerifyNow	ARU≥550 PRU≥240	12%	62.6%
Adeeb *et al.* 2017	402	Aneurysm treatment with Pipeline stent placement	325 mg asp+ 75 mg Clp daily (3-14 days before)	LTA VerifyNow Whole-blood lumiaggregometry	ASA platelet aggregation >20%, PRU>208 >6 Ω		28.8%

Clp = clopidogrel, Asp = Aspirin, ARU = aspirin reaction unit, PRU = P2Y12 reaction unit, LTA = Light Transmission Aggregometry, AUC = area under curve, ASA= acetylsalicylic acid, PFA-100 = Platelet Function Assay

20.7% and 25.4%, respectively. Aspirin resistance was significantly higher in the latter group compared to the former ($p < 0.001$). However, there was no difference between these two groups in terms of clopidogrel resistance. The resistance frequency in the patients who had flow diverter device was 17.6% for aspirin and 25.7% for clopidogrel.

DISCUSSION

In patients undergoing cerebrovascular stenting, development of thromboembolic complications due to platelet aggregation induced by usage of endovascular devices is the main problem [2]. Dual antiplatelet therapy with asprin and clopidogrel has been accepted as premedication method and post-procedural treatment in order to prevent these complications. However, the use of platelet function tests before neurosurgical procedures remains controversial. In contrast to lack of literature in neuravascular patients, the frequency of aspirin and clopidogrel resistance has been shown in different groups of patients receiving dual antiplatelet therapy (percutaneous coronary intervention, peripheral arterial disease, ischemic stroke, diabetes mellitus, etc.) and its effect on clinical outcomes is discussed [3, 5-10].

Several studies in the cardiology literature have shown that the incidence of aspirin resistance varies according to how it is defined and the differences in dosage and population used. The prevalence of aspirin resistance in patients undergoing percutaneous coronary intervention has been in a wide range of 1-55% [5]. In addition, clopidogrel resistance has been reported up to 35% in that patient group so far [3]. However, a number of multicenter, randomized controlled trials (GRAVITAS, ARCTIC, TRIGGER-PC), which were subsequently performed in patients with percutaneous coronary interventional procedures, did not show the overall clinical benefit of antiplatelet therapy according to the results of platelet function tests [6-8].

In studies conducted into patients with peripheral arterial disease, the incidence of aspirin resistance has been reported up to 60% and clopidogrel resistance up to 65% [9]. In several studies on ischemic stroke patients, aspirin and clopidogrel resistance rate was found to be 23% and 27%, respectively. Moreover, the risk of recurrent ischemic stroke or transient ischemic attack was reported higher in those patients with resistance to antiplatelets [10].

In patients undergoing neurovascular interventional procedures, platelet resistance tests, frequency of resistance and their association with clinical outcomes have been investigated in retrospective, single-center studies. In our study, the frequency of resistance was found to be 9.4% for aspirin and 23.8% for clopidogrel by Multiplate® test and they were similar to the frequency rates found in in the studies conducted so far. In these studies the prevelance of aspirin resistance was found to be between 2.1-17% and the frequency of clopidogrel resistance was found between 21-62.6% (Table 3) [2, 4, 11-28].

The patients with flow diverter stents evaluated seperately given the being more excessively used in last ten years and the frequency of resistance was found to be 17.6% for aspirin and 25.7% for clopidogrel in 35 patients with flow diverter devices at our hospital. Delgado Almandoz *et al*. [14] and Heller *et al*. [23] found the low response rate of clopidogrel in patients who underwent aneurysm treatment with flow diverter devices 26.2% (n = 44) and 4 % (n = 24), respectively. Oran *et al*. [4] revealed the low response rate of clopidogrel to be 25% (n = 100) with Multiplate® test in a group of patients with FDD and this rate is similar to ours. Moreover, Tan *et al*. [24] found the frequency of low response to clopidogrel to be 52.7% (n = 74) using FDD by VerifyNow test, which is the highest frequency of resistance reported to clopidogrel among patients with FDD.

The premedications with new antiplatelets, such as prasugrel and ticagrelor, are becoming increasingly used in neurovascular stenting, particularly with FDDs. In our unit, we prefer ticlopidine and prasugrel as premedication in patients who are resistant to clopidogrel. In a systematic review, dual antiplatelet regimens including ticagrelor or prasugrel are found to be safe for patients undergoing FDD procedures [29]. Besides, in another research, it was demonstrated that more than 98% of patients were within the optimal range with Multiplate® test after half-dose (30 mg) loading of prasugrel [30].

Although there are several ways of detecting platelet aggretation inhibition, Multiplate® test is used as resistance test in our center. Flechtenmacher *et al*. [28] compared antiplatelet resistance with LTA, VerifyNow and Multiplate® test in 97 patients who under-

went cerebrovascular stenting and found clopidogrel resistance to 47.6%, 50.5% and 35.9%, respectively. Accordingly, the highest resistance frequency was determined by VerifyNow test and the lowest resistance was reported by Multiplate® test. In the same study, the correlation between resistance results reported with LTA test and the risk of thromboembolic complications was found to be better than Multiplate® and VerifyNow tests. The LTA test is the gold standard for antiplatelet resistance; however, it is a time consuming test because of necessity to be used in a laboratory environment. The tests that can be performed patient-based are Multiplate® and VerifyNow. The VerifyNow test is widely used because it has the same principle as the LTA test and is a fully automated system. The Multiplate® test is a semi-automated system and can be performed at the bedside, such as VerifyNow, in the presence of trained stuffs [31].

As it can be understood from studies ever published, there is variability in the dose and duration of antiplatelet therapy and the cut-off values of antiplatelet resistance, as well as the patient population and stent indication in patients undergoing neurovascular procedure (Table 3). Therefore, it is inevitable that the frequency of resistance ranges in a wide variation. The general term is the presence of a group of patients in whom platelet inhibition is not sufficient despite dual antiplatelet therapy. However, there are usually single-center, retrospective studies investigating the prognosis in this patient group.

In our study, the frequency of detecting thromboembolic findings by radiological methods in patients with aspirin or clopidogrel resistance was lower in the resistant group but there was no statistically significant difference between the two groups. However, we reckon that the reason for the lower rate of thromboembolism in the resistant group is the change of medication in the patients who was with resistance to clopidogrel. Shim *et al*., in their meta-analysis, which reviewed the studies performed on patients undergoing neurosurgical procedures, emphasized that patients resistant to antiplatelet treatments had a higher risk of thromboembolic events than those with normal responses. They found stent placement was associated with thromboembolic risk in the resistant group in patients undergoing neurosurgical procedures. In addition, studies suggesting that re-regulated antiplatelet therapy regimens may help to reduce the risk of thromboembolic events in patients with resistance demonstrated by antiplatelet resistance test. However, due to the variable results between single-center studies, they emphasized that cautious approach should be taken among adjusting antiplatelet therapy with the results of antiplatelet resistance tests [32].

Limitations

Our study has some limitations. The most important one is that it is a single-centered study. Hence, it reflects the frequency of drug resistance on a single region. In addition, the effect of aspirin and clopidogrel resistance on clinical outcomes could not be evaluated due to the regulation of medication after resistance was demonstrated and absence of a control group owing to retrospective design of the study.

CONCLUSION

In conclusion, in this study the incidence of aspirin resistance was 9.4% and clopidogrel resistance was 23.8% in patients who underwent neurovascular stenting.The frequency of antiplatelet resistance is very variable among these patients, mainly due to variency in the patient population, stent indication, dose-duration of antiplatelet therapy administered and the tests used to determine antiplatelet resistance as well as the cut-off values of the tests. However, as it is seen in our study, there is a group of patients who do not have sufficient platelet aggregation inhibition despite antiplatelet therapy. For this reason, the resistant patient group can be determined by performing platelet inhibitation tests before the interventional procedure. The presence of antiplatelet resistance in these patients and the effect of individual-based antiplatelet therapy on clinical outcomes should be investigated in prospective randomized controlled trials.

Authors' Contribution

Study Conception: DA, HD, ŞO, MS; Study Design: DA, HD, ŞO, MS; Supervision: DA, HD, ŞO, MS; Funding: DA; Materials: DA; Data Collection and/or Processing: DA, HD, ŞO, MS; Statistical Analysis and/or Data Interpretation: DA, HD, ŞO, MS; Literature Review: DA, HD, ŞO, MS; Manuscript Preparation: DA, HD, ŞO, MS and Critical Review: DA, HD, ŞO, MS.

Conflict of interest

The authors disclosed no conflict of interest during the preparation or publication of this manuscript.

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