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1 **Efficacy of dual antiplatelet therapy for preventing recurrence of arterial thrombosis in**
2 **patients with antiphospholipid syndrome**

3

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18 Running title: Efficacy of DAPT in APS patients with arterial thrombosis

19

20 Conflict of interest

1 Tatsuya Atsumi reports personal fees from Chugai, during the conduct of the study; grants
2 and personal fees from Astellas, grants and personal fees from Takeda, grants and personal
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9

1 **Abstract**

2 OBJECTIVE: Warfarin is regarded as the standard treatment for preventing thrombotic
3 events in antiphospholipid syndrome (APS), but the recurrence rate is still high. Dual
4 antiplatelet therapy (DAPT) has been shown to be effective for the prevention of acute
5 coronary syndrome or stroke. The objective of this study was to evaluate the efficacy of
6 DAPT for the prevention of thrombosis recurrence in APS patients with history of arterial
7 thrombosis.

8 METHODS: This retrospective cohort study of APS patients was conducted at Hokkaido
9 University Hospital between 1990 and 2016. The secondary prophylactic effects and safety of
10 warfarin monotherapy (Wf), antiplatelet monotherapy (AP), warfarin and antiplatelet
11 combination therapy (Wf + AP) and DAPT were evaluated. The primary endpoints were set
12 as thrombosis-free and adverse events-free survival period. Adverse events were defined as
13 severe bleeding and death.

14 RESULTS: A total of 90 APS patients were enrolled. Thrombotic recurrence was found in 40
15 patients (35 arterial and 5 venous thromboses) and serious adverse events in 20 patients (9
16 severe bleeding events and 14 deaths). Kaplan-Meier analysis demonstrated a 10-year
17 recurrence-free survival rate of 62%. The recurrence rate per 100 patient-years were as
18 follows: Wf: 11.6, AP: 5.5, Wf: + AP: 3.7, DAPT: 1.8. We demonstrated that DAPT
19 significantly reduced the rate of recurrence compared with Wf (Log-rank $p = 0.001$). There

1 were no significant differences in the rate of serious adverse events among the groups.

2 CONCLUSION: DAPT might be considered as an effective and safe option for the
3 prophylaxis of recurrent arterial thrombosis in APS.

4

5 **Keywords**

6 Antiphospholipid syndrome (APS), dual antiplatelet therapy (DAPT), arterial thrombosis,
7 venous thrombosis, prophylaxis, safety

8

9 **Rheumatology key messages**

- 10 • This is the first study exploring dual antiplatelet therapy (DAPT) for APS patients.
11 • DAPT might be considered as an effective and safe option for APS patients.

12

1 **Introduction**

2 Antiphospholipid syndrome (APS) is an autoimmune disease characterized by thrombotic
3 events and pregnancy complications with persistently positive antiphospholipid antibodies
4 (aPL) [1]. APS patients suffer from thrombosis in both arteries and veins, whilst protein C
5 deficiency, Factor V Leiden, and other thrombophilia mostly affect the venous circulation.

6 According to the guidelines for the management of patients with APS,
7 anticoagulation using warfarin is recommended for secondary prophylaxis of arterial/venous
8 thrombosis by targeting the Prothrombin time-International normalized ratio (PT-INR)
9 between 2.0 to 3.0 [2]. On the other hand, the APS Workshop guidelines recommend that
10 APS patients with an arterial thrombotic event should be treated with warfarin at PT-INR
11 >3.0 or with antiplatelet plus warfarin combination therapy at PT-INR between 2.0 to 3.0 [3].
12 The difference between these recommendations may be due to the discrepancy in their main
13 objectives of avoiding treatment-related bleeding events [4] or preventing severe recurrent
14 thrombosis [5]. However, a major limitation in both recommendations is that no definitive
15 evidence has been shown to prevent recurrent arterial events.

16 Dual antiplatelet therapy (DAPT) is commonly used in clinical practice for the
17 secondary prevention of arterial thrombotic events in patients at high recurrence risk.
18 Defined as the combination of aspirin and a P2Y₁₂-receptor inhibitor, DAPT has
19 demonstrated superior efficacy over anticoagulant therapy in coronary artery disease.

1 Although there have been no reports of retrospective/prospective studies that compare the
2 effectiveness and safety of DAPT in APS patients [6], the benefit of antiplatelet therapy is
3 highly suggestive as most arterial thromboses recur as arterial thrombosis [7, 8]. Although
4 arterial thrombosis in APS is reported most frequently in Japan compared to other countries,
5 still the low prevalence of disease makes prospective trials very difficult [5, 8]. Therefore, our
6 longitudinal APS cohort was used to evaluate the benefit of DAPT in patients with a history
7 of arterial thrombosis.

8

9 **Methods**

10 This retrospective cohort study of patients with APS, was conducted in a single institution.
11 Patients with the diagnosis of APS was extracted from the autoimmune disease database of
12 our outpatient clinic between April 1990 and March 2016, and the diagnosis verified by the
13 attending physicians and authors according to the Sydney-revised Sapporo criteria for
14 definite APS [1]. The coexistence of systemic lupus erythematosus was diagnosed according
15 to the American College of Rheumatology (ACR) revised criteria [9].

16 We enrolled APS patients with a history of an arterial thrombotic event who received
17 prophylactic treatment for recurrent thrombosis for at least 2 years. The observation period of
18 each patient was defined to begin at the time of the first arterial thrombotic event, regardless
19 of previous venous thrombotic events or pregnancy complications and end either at the time
20 of an event (recurrence of arterial and/or venous thrombosis, severe bleeding event, or death)

1 or at the end of medical records. APS patients without manifestations of arterial thrombosis
2 or with followed-up periods less than 2 years were excluded. The selection of the
3 prophylactic regimen was based on the individual physician's judgement in accordance with
4 the standard medical care in Japan at the time. All treating physicians were board-certified
5 rheumatologists by the Japan College of Rheumatology, and therapeutic regimen
6 administered following the corresponding guidelines of APS [2] and stroke [10].

7 Patients were divided into four groups based on their treatment regimen: warfarin
8 monotherapy (Wf); single antiplatelet therapy (AP); warfarin and antiplatelet combination
9 therapy (Wf + AP); or dual antiplatelet therapy (DAPT) (Figure S1). Specific antiplatelet
10 drugs included aspirin, ticlopidine, clopidogrel, cilostazol, dipyridamole, beraprost sodium,
11 sarpogrelate hydrochloride, and dilazep dihydrochloride (Table S1). Anticoagulant refers
12 specifically to warfarin in this study as patients on treatment with direct oral anticoagulants
13 were excluded due to off label use of these agents for arterial thrombosis without atrial
14 fibrillation in Japan. None of the patients were on hydroxichloroquine. In Japan,
15 hydroxichloroquine has been used off-label for SLE until its approval on July 2015.

16 The primary endpoints were set as event free survival period and events were
17 defined as the recurrence of thrombosis in either arterial or venous circulation, severe
18 bleeding events, and death. The presence of thrombosis was confirmed by imaging and
19 severe bleeding was defined as those events that required hospitalization and/or blood

1 transfusion.

2 Risk factors for arterial thrombosis including hypertension, diabetes mellitus,
3 dyslipidaemia, glucocorticoid use and smoking were recorded at the end of the observation
4 period. Antiphospholipid antibodies were assayed in all the patients at the first visit to the
5 autoimmune outpatient clinic and at least the second time, separated by at least twelve weeks
6 (definition of risk factor and aPL assay are shown in supplementary data). The
7 antiphospholipid score (aPL-S), a quantitative marker that represents aPL profile, was
8 calculated in each patient [11].

9 This study was conducted in accordance with ethical principles of the Declaration of
10 Helsinki and Good Clinical Practice guidelines and approved by Hokkaido University
11 Hospital ethics committee (approval number: 017-0034).

12

13 **Statistical analysis**

14 Categorical variables were described as counts and percentages. Continuous variables were
15 expressed as the median and quartiles. To identify differences between groups, the Mann–
16 Whitney U test and the Kruskal-Wallis test were performed. Kaplan-Meier curves were
17 applied to estimate the value of secondary prevention therapy and safety, using thrombotic
18 events and mortality/severe bleeding events. Cox regression analysis was performed to
19 identify the risk factors for recurrence according to therapy and variables related to arterial

1 thrombosis. In all statistical analyses, $p < 0.05$ was taken to indicate statistical significance.
2 All statistical analyses were performed using JMP® Pro 12.2.0 (SAS Institute Inc., Cary,
3 North Carolina, USA).

4

5 **Results**

6 One hundred and twelve patients out of the 206 patients in the APS cohort had a history of
7 arterial thrombosis as the first thrombotic event and received a prophylactic regimen. Ninety
8 patients met the inclusion criteria and were enrolled in this analysis. Patients were divided
9 into four groups according to the regimen as follows: Wf (n=13), AP (n=41), Wf + AP (n=21)
10 or DAPT (n=15) (Figure S1).

11

12 **Baseline Characteristics**

13 Patients' baseline characteristics are summarized in Table 1. Seventy three out of 90 (81%)
14 were female, and cerebral infarction (81/90 patients (90%)) was the most frequent incident
15 thrombotic event. The median observation period was 8 years [interquartile range (IQR) 5–
16 13]. No statistically significant differences were found in risk factors for arterial thrombosis
17 among the 4 groups (Table 1, S2). The frequency of coronary heart disease (CHD), deep vein
18 thrombosis (DVT), pulmonary embolism (PE) and superficial thrombophlebitis were
19 statistically significantly different among the 4 groups at baseline ($p=0.025$, $p=0.022$,
20 $p=0.004$, $p=0.017$, respectively).

1

2 **Recurrence rate**

3 Recurrent events were observed in 40 patients (recurrence rate 4.96 per 100 patient-years)
4 with 35 arterial and 5 venous thromboses (Table S3). The most common arterial and venous
5 thrombotic recurrence was cerebral infarction and DVT in 29 (32.2%) and 3 patients (3.3%),
6 respectively. There were statistically significant differences in the recurrence rates of cerebral
7 infarction among the 4 groups ($p=0.004$), with AP ($p=0.024$), Wf + AP ($p=0.034$), and DAPT
8 ($p=0.001$) having significantly lower incidences relative to Wf.

9 Thrombosis-free intervals during treatment calculated by the Kaplan–Meier method
10 are presented in Figure 1. Warfarin monotherapy was less effective for prevention of
11 thrombosis than other treatment options (Log-rank $p = 0.0027$). INR levels in Wf group were
12 for moderate-intensity: PT-INR between 1.5 to 2.5 (on recurrence; median PT-INR, [range]
13 2.17 [1.75 - 2.39]). The frequency of thrombotic recurrence between Wf and DAPT, and also
14 between Wf and Wf + AP were statistically significantly different (Log-rank $p = 0.001$, $p =$
15 0.009 , respectively). Warfarin monotherapy had the highest rate of recurrence (11.58 per 100
16 patient-years). In the other group, the recurrence rate expressed as per 100 patient-years, were
17 as follows: AP: 5.47, Wf + AP: 3.72, DAPT: 1.81. Warfarin monotherapy was identified as an
18 independent risk factor in adjusted Cox proportional hazards models (Hazard Ratio 4.23,
19 95% confidence interval 1.69 - 10.38, $p = 0.003$) (Table S4). Since the patients with high

1 risk of ischemic heart disease might have an impact on the results, the sub-analysis excluding
2 patients with recurrence of cardiac events were performed; Wf monotherapy was still
3 identified as an independent risk factor (Figure S2).

4

5 **Safety assessment**

6 Severe bleeding events and/or mortality occurred in 20 patients (22.2%, 3.58 per 100
7 patient-years) (Table S3). During the follow-up period, there were 9 patients (10%) with
8 severe bleeding events and 14 deaths (15.6%). Three patients died of a severe bleeding (aortic
9 dissection in AP, alveolar haemorrhage in Wf + AP, aortic aneurysm rupture in DAPT), and 2
10 patients died of cerebral infarction. Other causes of death were interstitial pneumonia (n=2),
11 and infection/sepsis, lung cancer, amyotrophic lateral sclerosis and drowning (n=1 each). In
12 three patients, the causes of death could not be identified. No statistically significant
13 differences in frequency of severe bleeding or death were observed among the 4 groups
14 (Figure S3). Per 100 patient-years, serious bleeding events and/or mortality rate in the four
15 groups were as follows: Wf : 0.59, AP: 2.14, Wf + AP: 2.21, DAPT: 2.89.

16

17 **Discussion**

18 In this study, we found that the effectiveness of DAPT as a secondary prophylaxis against
19 arterial thrombosis in APS patients was similar to that of Wf + AP and superior to warfarin

1 alone. The differences in efficacy may be attributed to the constitutional difference in arterial
2 thrombi initiated as platelet aggregates, and venous thrombi consisting mainly of fibrin [12],
3 with the former being more effectively prevented by anti-platelet agents. The high recurrence
4 rate of cerebral infarction in the Wf monotherapy group is suggestive of this mechanism
5 (Table S3).

6 Considering that most recurrences took place in the same vascular bed as the original
7 thrombosis, most physicians were choosing secondary prevention therapy including warfarin
8 for the patients with the past history of venous thrombosis (Table 1). In fact, warfarin
9 monotherapy was effective in preventing new venous thrombosis occurrence (recurrence rate:
10 1.05 per 100 patient-years), but without similar effectiveness for arterial thrombosis
11 (recurrence rate: 10.53 per 100 patient-years). Although the average PT-INR (2.17) herein for
12 the Wf group was lower than those recommended in the guidelines (target PT-INR (2.5-3.5)),
13 this reflects the real world management of warfarin treatment at the time of administration.
14 Previous studies in APS also reported the difficulty to keep the optimal PT-INR range
15 without bleeding events [13].

16 A systematic review and meta-analysis of DAPT for secondary prevention of
17 myocardial infarction and stroke has shown that long-term use of DAPT was associated with
18 lower mortality compared to other prophylactic regimen [14]. Although treatment-related
19 bleeding events are of serious concern during DAPT, we did not find an increased bleeding

1 risk, most likely due to the younger age of our APS population (median age 45 years [range
2 31.3 - 53.0 years]) compared to the non-APS thrombotic population (average age \pm standard
3 deviation: 64.4 ± 9.5 years) [14]. Older age have been reported as a risk of treatment-related
4 bleeding [15]. While aspirin is the most frequently used antiplatelet drug, aspirin has a major
5 disadvantage of “aspirin resistance” [16]. In fact, aspirin resistance were reported in 27% of
6 patients [17] and were associated with short and long-term mortality in patients with acute
7 ischemic stroke [18]. The use of DAPT may be an effective strategy to resolve this issue.

8 There are some important limitations to be considered in this single centre Japanese
9 study. Although longitudinal data of at least two years in 90 patients is worth reporting,
10 appropriate reproducibility is warranted in a multi-centered study. On a similar note, APS
11 patients with diverse ethnic and genetic backgrounds need to be considered. In terms of study
12 design, selection bias inherent to the retrospective observational design warrants further
13 confirmation of the superiority of DAPT in a prospective fashion. Furthermore, the small
14 number of patients on DAPT precluded our comparison among the specific antiplatelet
15 regimens, and the small number of patients on each treatment may contribute to the safety
16 assessment. Although cerebral infarction was confirmed by brain MRI or magnetic resonance
17 angiogram or angiography in all patients, differential diagnosis between cerebral infarction
18 and cerebral vasculitis may be difficult in some patients with SLE and APS due to the
19 diagnostic limitations. Nevertheless, we believe our study would shed a light to any

1 prospective clinical study focused on the prophylaxis of arterial thrombosis using DAPT in
2 APS patients.

3 In conclusion, our results indicate that DAPT might be an effective option for
4 preventing arterial thrombosis in patients with APS.

5

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13

14 **Supplementary data**

15 Supplementary data are available at *Rheumatology* online.

16

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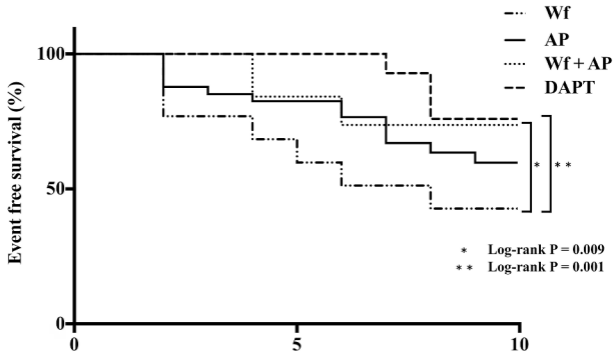
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14 **Figure Legend**

15 **Figure 1. Ten-years thrombosis-free survival.**

16 Data were estimated using the Kaplan-Meier curves. P-values <0.05. Ten-years
17 thrombosis-free survival rate was 62%. Warfarin was less effective for prevention of
18 thrombosis than other treatment options (Log-rank P=0.0027). There was statistically
19 significant difference in the frequency of thrombotic recurrence events between Wf and dual

- 1 antiplatelet therapy (DAPT) (* * Log-rank P = 0.001) or Wf + AP combination therapy (*
- 2 Log-rank P = 0.009). The intensity of warfarin therapy on recurrence was at a
- 3 moderate-intensity level (median PT-INR, [range] 2.17 [1.75 - 2.39]).



	0	1	2	3	4	5	6	7	8	9	10
Wf (N)	13	13	13	9	9	8	7	7	6	5	4
AP (N)	41	41	41	33	32	29	28	24	19	17	15
Wf+AP (N)	21	21	21	20	19	19	16	13	13	11	11
DAPT (N)	15	15	15	15	15	15	15	14	11	11	11

Table 1. Baseline clinical and demographic characteristics of the patients

	Total (N=90)	Wf (N=13)	AP (N=41)	Wf + AP (N=21)	DAPT (N=15)	P-value
Female (%)	73 (81.1%)	10 (76.9%)	37 (90.2%)	14 (66.7%)	12 (80.0%)	0.156
Median age at disease onset (IQRrange): years	45 [31-53]	34 [26-51]	46 [34-56]	46 [29-53]	44 [36-51.5]	0.594
Median follow up period (range): years	8 [5-13]	6 [2-10]	7 [4-12]	9 [6-17]	11 [7.5-14]	0.072
Primary APS	37 (41.1%)	4 (30.8%)	20 (48.8%)	9 (42.9%)	4 (26.7%)	0.397
Secondary APS (SLE) on steroids	53 (58.9%)	9 (69.2%)	21 (51.2%)	12 (57.1%)	11 (73.3%)	0.397
Smoking	31 (37.8%)	5 (38.5%)	15 (36.6%)	6 (28.6%)	5 (33.3%)	0.916
Hypertension	51 (56.7%)	9 (69.2%)	25 (61.0%)	9 (42.9%)	7 (46.7%)	0.341
Dyslipidemia	40 (44.4%)	9 (69.2%)	18 (43.9%)	9 (42.9%)	4 (26.7%)	0.151
Diabetes Mellitus	16 (17.8%)	2 (15.4%)	5 (12.2%)	5 (23.8%)	4 (26.7%)	0.527
aPL-S	31 [14-50.5]	33 [13.0-71.0]	26 [13.0-42.0]	35 [15.0-54.5]	33 [20.0-41.0]	0.434
Arterial thrombosis						
Cerebral infarction	81 (90.0%)	11 (84.6%)	39 (95.1%)	20 (95.2%)	11 (73.3%)	0.115
Coronary heart disease	8 (8.9%)	2 (15.3%)	2 (4.9%)	0	4 (26.7%)	0.025*
Arterial ischemia in legs	3 (3.3%)	0	1 (2.4%)	2 (9.5%)	0	0.296
Mesenteric artery occlusion	3 (3.3%)	1 (7.7%)	1 (2.4%)	1 (4.8%)	0	0.612
Central retinal artery occlusion	2 (2.2%)	0	1 (2.4%)	1 (4.8%)	0	0.737
Renal infarction	1 (1.1%)	0	0	1 (4.8%)	0	0.400
Past history of venous thrombosis						
Deep vein thrombosis	14 (15.6%)	5 (38.5%)	2 (4.9%)	5 (23.8%)	2 (13.3%)	0.022*
Pulmonary embolism	7 (7.8%)	4 (30.8%)	0	2 (9.5%)	1 (6.7%)	0.004*
Superficial thrombophlebitis	2 (2.2%)	0	0	0	2 (13.3%)	0.017*

*P-values <0.05. P-values are multiple comparison between 4 groups and were estimated using Kruskal-Wallis test. Age, follow-up period and antiphospholipid score (aPL-S) are presented as the median (IQR: Interquartile range 25th -75th). N: number of patients, Wf: warfarin monotherapy, AP: antiplatelet monotherapy, Wf + AP: warfarin and antiplatelet combination therapy, DAPT: dual antiplatelet therapy, APS: antiphospholipid syndrome. SLE: systemic lupus erythematosus