Preliminary Experience with the Cangrelor for the Management of Antiplatelet Therapy in the Setting of Endovascular Treatment of Challenging Intracranial Aneurysms

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Abstract

Background and Purpose:
Cangrelor is a $P2Y_{12}$ inhibitor that presents the advantage of having a short half-life. Its use may be helpful in the management of antiplatelet therapy for patients treated with stent assisted coiling or flow-diverter stents. The purpose of our study was to report our early experience in using cangrelor for such indications.

Material and Methods:
From October 2017 to November 2018, seven consecutive patients (5 females, 2 males, mean age = 56 y) were managed with cangrelor as antiplatelet therapy, combined with aspirin, for stent-assisted coiling embolizations and flow-diverter embolizations of challenging intra-cranial aneurysms. 71.4% (5/7) of the aneurysms were ruptured ones treated at the acute phase. In one case, the cangrelor was used as an alternative to clopidogrel in an asymptomatic hemorrhagic complication after stent assisted coiling to better control a possible worsening of the intracranial bleeding.
Anti-aggregation protocols, including cangrelor, were systematically recorded.

Results:
One patient (14%) with a complex ruptured MCA aneurysm treated by flow diverter stent experienced a severe intracranial hemorrhage, which occurred after switching the cangrelor to ticagrelor and eventually lead to death. No hemorrhagic complication under cangrelor was recorded for the six remaining patients. No mRS shift was observed at discharge, except for the patient who died. Six out of the seven patients had a mRS ≤ 2 at follow-up.

Conclusion:
Cangrelor is a new anti-platelet therapy with a $P2Y_{12}$ inhibiting effect, which is manoeuvrable, owing to its short half-life. This cases series present a pilot experience with promising results in terms of antiplatelet management for challenging intracranial aneurysms treated by stent assisted coiling or flow-diverter stents.

Acronyms and abbreviations:
ACA: anterior cerebral artery, **DSA**: digital subtraction angiography, **ICA**: internal carotid artery, **FDS**: flow diverter stent, **MCA**: middle cerebral artery, **mRS**: modified Rankin Scale, **PCI**: percutaneous coronary intervention

Introduction

Antiplatelet therapy is a key medication in the setting of stenting for intracranial aneurysms [1] [2]. Indeed, during the first months after the stent deployment, in order to avoid (or a least reduce) the risk of thromboembolic complications, an antiplatelet therapy is required. Derived from the cardiologists' practice for the management of stents in coronary diseases [3], interventional neuroradiologists usually use dual antiplatelet therapy (aspirin plus a $P2Y_{12}$ receptor inhibitor [clopidogrel, prasugrel or ticagrelor]) during the first weeks/months after stenting (with no consensus between the different teams around the world), and then switch for a single anti-platelet therapy (for a total of at least one year in our Institution). The drawback of this strategy is that most of the antiplatelet agents used in the field of interventional neuroradiology have a slow onset of action (2-8 hours for clopidogrel, for instance) [4], thus requiring a loading dose before the endovascular treatment. Additionally, the long duration of platelet inhibition induced by $P2Y_{12}$ inhibitors [4] is challenging for the management of hemorrhagic complications or unplanned high bleeding risk procedures, including ventricular drainage setting. Moreover, platelet inhibition induced by some antiplatelet agents, like ticagrelor, is difficult to neutralize, which may lead to dramatic complication in case of hemorrhage [5].

Cangrelor is a $P2Y_{12}$ inhibitor, which received the FDA approval for percutaneous coronary interventions (PCI) in June 2015 [6]. Cangrelor is an active drug, which does not require activation by a metabolic conversion. This mechanism is different from other antiplatelet medications such as clopidogrel, which is a prodrug that requires a conversion to be activated. Interestingly, the cangrelor is the only $P2Y_{12}$ inhibitor that is available in IV form.

The pharmacokinetic of cangrelor is characterized by a quick onset and offset of action with a clearance of 50 l/h and a half-life of 3 to 5 min [7]. Moreover, the effect of the cangrelor cessed rapidly after the administration has been stopped and the normal platelet function restoration is thereafter obtained within one hour [7].

The very short half-life of cangrelor may be interesting in the field of interventional neuroradiology, especially for the management of intracranial hemorrhages complicating stent-assisted coiling or flow diversion. The need for an emergent ventricular drainage in patients recently treated with an intracranial stent may be another situation in which cangrelor may be a valuable medication.

We present herein our early experience in using cangrelor for the management of antiplatelet therapy at the acute phase of stent-assisted coiling or flow-diverter treatment.

Material and Methods

Study design

Retrospective observational case series.

Patient population

From October 2017 to November 2018, all adult (≥ 18 years) patients treated at our Institution with cangrelor as antiplatelet regimen for stent assisted coiling or flow diversion for an intracranial aneurysm were systematically reviewed. Patients' demographics and aneurysms' characteristics (ruptured/unruptured status, aneurysm's shape, intrasaccular thrombosis, location, shape, largest diameter and aneurysm's neck size) were systematically assessed.

Procedures

In all patients, details about the endovascular procedure were collected in the medical chart. Details about the antiplatelet regimen, before and after the procedure, as well as for the management in the intensive care unit (ICU) was also systematically recorded.

Cangrelor administration protocol

All patients had complete blood assays, including platelets and red blood cells count, as well as coagulation work-up, before cangrelor infusion. No platelet aggregometry testing was performed before cangrelor administration, since no patient was preloaded by antiplatelet therapy before stenting, to avoid any bleeding from the aneurysm.

Cangrelor was used in all cases with a dose derived from the cardiologists'

experience: 30 micrograms/kg IV bolus followed immediately by 4 micrograms/kg per minute IV infusion [5].

Safety

Procedure-related complications were systematically recorded. These complications were divided into major complications (death, symptomatic intracranial hemorrhage, acute ischemic stroke leading to disability, groin puncture complications requiring surgical repair or blood transfusion) and minor complications (transient ischemic attack, acute ischemic stroke that did not lead to disability, asymptomatic/ paucisymptomatic intracranial hemorrhage, minor puncture site complication).

Any external or internal bleeding that occurred during the hospital stay or after discharge was systematically recorded.

Angiographic and clinical outcomes

Immediate angiographic outcome was evaluated on DSA in working projection at the end of the procedure, and was graded according to the Roy-Raymond [8], the O'Kelly-Marrota [9] and the Cekirge-Saatci [10] grading scales. Stent occlusion or in-stent thrombosis were systematically assessed on angiographic control. In 3 out of the 6 surviving patients (50%), a 6-months MR angiography was performed. Only 1/6 patients (17%) had a one-year DSA since several patients were treated recently, less than one year ago. On MRA follow-up, aneurysm occlusion was graded according to the Roy-Raymond score [8]. In the patient who underwent the one-year DSA follow-up, aneurysm's sac occlusion was graded on the Roy-Raymond score [8], the O'Kelly-Marrota [9] and the Cekirge-Saatci [10] grading scales.

Ethical statement

The use of cangrelor was off-labelled in our study. All cases were complex ones, with no alternative to intracranial stenting. The choice to treat these patients under cangrelor was made through a multidisciplinary meeting with neurosurgeons and anesthesiologists. Patients' family was informed before each treatment of the strategy that was chosen and gave an oral consent.

The need for patients' informed consent for retrospective analyses of records and imaging data was waived by our IRB. This work adheres to the World Medical Association Declaration of Helsinki.

Results

Patients' demographics/aneurysms' characteristics

Patients' demographics, aneurysms' characteristics and details on the endovascular procedures are summarized in ***Table 1***.

Seven consecutive adult patients undergoing an endovascular treatment for an intracranial aneurysm were included from October 2017 to November 2018 in a single center (5 females and 2 males, mean age: 56 ±10.4 years). Five patients presented a ruptured aneurysm (including 2 ruptured blister-like aneurysms), not eligible for regular coiling or clipping, treated at the acute phase with a flow diverter stent (FDS) (silk stent; n = 1 [Balt, Montmorency, France], Pipeline Embolization Device [PED]; n = 3 [eV3/Medtronic, Irvine, CA] and P64; n = 1 [Phenox, Bochum, Germany]. In one patient (Patient # 1), 2 FDSs (Silk) were used in a telescopic fashion. One of the patients treated by FDS had a compressive large partially thrombosed aneurysm at the distal aspect of the basilar artery. In none of the aneurysms treated by FDS additional coils were used. Indeed, intrasaccular coiling was deemed too dangerous in our 2 blister-like aneurysms cases, and for the remaining fusiform or partially thrombosed aneurysms, coiling seemed inappropriate. Two patients were treated using non-flow diverter stents (BB Leo, Balt): in the first case, the cangrelor was used in an asymptomatic hemorrhage complicating a stent-assisted coiling of an unruptured aneurysm (the patient bled under ticagrelor; which was switched to cangrelor to reduce the risk of bleeding worsening); in the second case, cangrelor was required for a bail-out stenting in a ruptured pericallosal aneurysm treated firstly by balloon assisted coiling. In the later case, a stent was deployed due to coil loop protrusion.

Two aneurysms (28.6%) were located on the MCA bifurcation/trifurcation. One of these 2 patients (Patient # 1) was treated by a flow diverter stent because no other option (either endovascular or surgical) was deemed feasible; the aneurysm involving both the M1 segment and the M2 branches of a MCA trifurcation. According to the literature [11] [12] and to our local experience, FDS was deemed to be the most suitable option in this challenging case. Two aneurysms were located on the distal internal carotid artery (ICA) (28.6%), one on the A1 anterior cerebral artery (ACA) (14.3%), one on the pericallosal artery and a last one on the basilar artery (14.3%). Average aneurysms' maximum diameter was 9.0 ± 8.1 mm (range: 1.9-23); average neck diameter was 5.8 ± 5.3 mm (range: 0.5-13).

Stenting procedures/antiplatelet management

All the patients were treated under general anesthesia via a femoral approach. All stentings were performed with a tri-axial system using a 6F long sheath, an intermediate supple catheter (5F or 6F) and a microcatheter. Five patients were treated with a flow diverter stent (for a ruptured MCA trifurcation aneurysm, for an unruptured compressive basilar artery aneurysm, for a ruptured serpentine ICA aneurysm and for two blisters aneurysms, respectively); two patients were treated with a low profile braided stent for an unruptured MCA aneurysm and for a ruptured pericallosal aneurysm.

For the 5 patients treated at the acute phase, no preprocedural antiplatelet loading was performed (**Fig. 1**). The patients received the IV bolus of cangrelor within the 10 min before the stent positioning and an IV bolus of 250 mg aspirin 30 min before the stent deployment. Then, cangrelor infusion was pursued with an electric pump for 12 to 48h, before switching to ticagrelor 90 mg twice a day.

All patients had systematically a postoperative CT scan to avoid early hemorrhagic complication. In case of clinical worsening during the following hours after the procedure, a brain MRI, including at least diffusion-weighted and T2*-weighted sequences, was performed to depict any ischemic or hemorrhagic complication.

Antiplatelet therapy bridging

In 3 patients, cangrelor was used in a bridging fashion. One patient (Patient # 5) was switched from ticagrelor to cangrelor at D21 for ventricular drainage removal. In one patient (Patient # 3), the cangrelor was used as an alternative to ticagrelor to better control a potential worsening of an intracranial hemorrhage in the aftermath of a stent-assisted coiling. The patient experienced a spontaneous and asymptomatic intraparenchymal hematoma following stent assisted coiling of an unruptured MCA aneurysm depicted at D1 on CT scan. The patient was treated by aspirin (75 mg/d) and ticagrelor (90 mg x2/d) when she bled. The aspirin was pursued at the same dose and the ticagrelor stopped. Cangrelor was started 3 days after the bleeding event for 24h. Then, ticagrelor was resumed, and the cangrelor stopped 3h after the first dose of ticagrelor. The patient did not experience growth of the hematoma or rebleeding; she discharged symptom free.

Finally, a last patient (Patient # 2) required a ventricular drainage due to the occurrence of a hydrocephalus 20 days after the treatment of a large basilar artery aneurysm (**Fig. 2**). The hydrocephalus was revealed by major headache, and conscious disorder. Dual antiplatelet therapy was modified preoperatively as follows: aspirin (75 mg/d) was continued, ticagrelor (90 mg twice a day) was stopped, cangrelor (dose: 0.75 µg/kg/min) was introduced 3 days after ticagrelor discontinuation. The ventricular drainage was then positioned 2 hours after having

stopped the cangrelor. Afterwards, the cangrelor was resumed 12h after the ventricular drainage setting. Finally, the cangrelor was stopped and the ticagrelor reintroduced at day 2.

Safety

Only one (14%) major procedure-related complication was recorded (Patient # 1), which consisted in an acute intracranial hemorrhage 12h after the endovascular procedure with FDS in an MCA aneurysm, while the patient was under ticagrelor, after switching from cangrelor to ticagrelor. According to the MRI findings, this complication corresponded to a hemorrhagic transformation of an acute ischemic infarct, which eventually lead to death due to rapid growth of the hematoma. In the 6 remaining patients, no bleeding (either intracranial or from the groin puncture) was recorded under cangrelor.

No in stent-thrombosis or stent occlusion was recorded.

Clinical and angiographic outcomes

In 6/7 patients treated in our cases (85.7%), a Roy-Raymond [8] grade C angiographic result was seen at the end of the procedure. Most of these patients (5/6; 83.3%) were treated with flow diverter stent. In the remaining patient, treated by stent assisted coiling, a complete grade A occlusion was recorded at the end of the endovascular procedure.

Average clinical follow-up was 7.3 ± 3.6 months days (range 4-13). One patient (Patient # 1) died six days after the procedure from an intracranial hemorrhage. At

discharge, 5 patients (71.4%) were mRS 0-2; 2 patients (28.6%) were mRS >2. At last clinical follow-up, all surviving patients (6/6) has a mRS ≤ 2.

Angiographic follow-up was available in 4/6 of the surviving patients (66.7%) and showed a Roy-Raymond [8] grade A occlusion in one patient, grade B occlusion in one patient, and grade C occlusion in 2 patients. The remaining patients did not have angiographic follow-up since they were treated very recently.

Discussion

Our short case series underlines the feasibility of using cangrelor for the management of challenging cases of stent-assisted coiling or flow-diverter stent embolizations.

Safety

In our series, no case of stent occlusion or in-stent thrombosis was recorded. Only one case of severe hemorrhage occurred in our short case series, in a highly challenging ruptured MCA aneurysm. Interestingly, the hemorrhage occurred 12h after the treatment, under ticagrelor, after switching from cangrelor to ticagrelor. In the remaining cases, cangrelor allowed us to treat successfully and safely ruptured aneurysms treated with flow diverter stents, hemorrhagic complication in an unruptured aneurysm treated by stent assisted coiling (switch from ticagrelor to cangrelor to avoid increasing of the hematoma), and a case of hydrocephalus following flow diversion which required emergent ventricular drainage.

It is noteworthy that all the hemorrhages recorded in our series (n = 2, with one asymptomatic hemorrhage) occurred under ticagrelor and not under cangrelor. In these cases, we switched ticagrelor for cangrelor in order to better control the risk of worsening of the hematoma. This strategy was successful in one out of the 2 cases; one hematoma increased in size, leading to a fatal outcome, the other one remained stable and asymptomatic.

The rational for using ticagrelor in ruptured aneurysms is that the resistance to ticagrelor is very low, compared to clopidogrel. It appeared to us too dangerous to give the patients a loading dose for platelet aggregometry testing in ruptured aneurysms, owing to the significant early rebleeding risk. That is the reason why we chose ticagrelor instead of clopidogrel; in order to reduce the risk of resistance, and thus the risk of thrombo-embolic complications. We acknowledge the fact that

bleeding risk may be slightly higher with ticagrelor compared to clopidogrel. However, there are some data comparing both antiplatelet therapies for intracranial stenting, showing no significantly higher bleeding risks with ticagrelor [13].

Rational for using cangrelor in interventional neuroradiology

Cangrelor is an emerging medication used in the cardiology field for PCI [14-16]. It has been shown that cangrelor reduces the occurrence of periprocedural thrombo-embolic complications after PCI compared to clopidogrel, without increase of the periprocedural severe/moderate bleeding risk [17].

So far, only one case series has been published on the safety and effectiveness of the cangrelor for intracranial/cervical stenting [18]. In this article, the authors reported their preliminary experience with cangrelor in 8 patients. Most of the patients of this series (7/8; 87.5%) had a stenting for intracranial (1/7; 14.3%) or cervical (6/7; 85.7%) arterial occlusion in the setting of acute ischemic stroke in most cases (5/7; 74.4%); only one patient was treated for an intracranial aneurysm with a flow diverter stent.

Recent advances in the design of FDSs, like coating or surface modification with phosphorilcholine, may help to treat patients with ruptured intracranial aneurysms with FDS under a single antiplatelet therapy. Animal studies [19] as well as first case series in humans [20] using these devices are promising. However, strong evidences on the safety and effectiveness of such devices with only one antiplatelet therapy are still lacking. Additionally, even though complete aneurysm occlusion is rarely obtained at the end of the procedure in flow diversion, data from the literature [21] as well as our local experience [22] show that dual antiplatelet therapy is still a reasonable option in patients treated with FDSs at the acute phase; the flow diversion, by redirecting the blood flow in the parent artery, probably reduces the stress exerted on the aneurysm's

wall and thus prevent rebleeding in most cases.

Cangrelor dose

It has been recently shown in the literature that an adequate platelet inhibition could be obtained with lower cangrelor doses (even < 0.5 μg/kg/min) than the standard one for PCI (bolus of 30 μg/kg, then infusion of 4 μg/kg/min). Aguilar-Salinas et al [18] have proposed in their recent case series of intracranial/cervical stenting (mainly in the setting of acute ischemic stroke) to use half of the standard dose for PCI: 15 μg/kg bolus, followed by a 2.0 μg/kg/min IV infusion of cangrelor for a minimum of 2 hours. However, we chose in our series to keep the full dose of the protocol used by the cardiologists (bolus of 30 μg/kg, then infusion of 4 μg/kg/min) because we thought that the risk a ischemic complication/stent occlusion was high in our patients treated by braided stents (most of them being flow diverter stents [71.4%] which are know as being highly thrombogenic). Some data are also available in the cardiologists' literature on the safety of cangrelor over-dose in PCI. There is not a statistically significant higher bleeding risk in patients who received cangrelor over-dose as compared to the standard dose for PCI [23]. However, one should keep in mind that risk of intracranial bleeding, which may lead to devastating consequences, is much more higher for intracranial stenting than for PCI.

Advantages of cangrelor

In addition to its "on-off" activity, another major advantage of the cangrelor is that its efficacy does not depend on its metabolism. Contrary to clopidogrel, cangrelor's

efficacy is not impacted by genetics variations. Moreover, no dose adjustment is required for patients with renal or hepatic impairment.

In our cases, in contrast with the recommendations for cardiac percutaneous interventions [17], we chose to continue the cangrelor for 48h before switching for ticagrelor since there was a high estimated bleeding risk (most of the patients of our cases series had ruptured aneurysms presenting a potential risk of rebleeding, who may also require secondarily a ventricular drainage).

In bridging strategy (for the placement of a ventricular drainage for instance), we chose a dose of 0.75 µg/kg/min based on the results of both phase 2 studies evaluating the dose-response curve of cangrelor on healthy subject and on randomized controlled trials focused on coronary artery bypass grafting surgery [24]. According to these data, a dose of 0.75 µg/kg/min is sufficient to ensure a platelet aggregation inhibition while not significantly increasing the bleeding risk.

Cangrelor drawbacks

There are two main drawbacks for the use of cangrelor. First, it requires careful management, preferentially in an intensive care unit, to guarantee a continuous IV infusion. Thus, clearly defined protocols should be used by the physicians and the nurses to avoid any discontinuity in the platelet inhibition due to the short half-life of the cangrelor.

Second, the cangrelor is an expansive medication (350 euros/vial) [25]. Thus, this medication should be used with parsimony and cannot be reasonably administered on a long-time period.

Limitations of the study

The major limitation of our case series is its retrospective fashion and the small number of patients included. Additionally, there was no control group with regular antiplatelet therapy in our study. However, the goal of this study was to present our early experience in the use of the cangrelor, to share it with the interventional neuroradiology community and to provide new insights for emergent stent-assisted coiling treatments and flow-diverter embolizations.

Conclusion

Our case series shows the feasibility of using cangrelor, combined with aspirin, as an antiplatelet therapy in stent-assisted embolization or flow-diverter therapy for acutely ruptured aneurysms. This medication is manoeuvrable, owing to its short half-life, which could be useful in challenging cases where high hemorrhagic and thrombotic risks are coexisting. It may also be a useful option for patients requiring dual antiplatelet therapy while facing unplanned ventricular drainage. However, comparison with standard antiplatelet regimen in a larger prospective patient cohort is warranted.

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Table

Table 1. Population's characteristics and outcomes

Patient nb	1	2	3	4	5	6	7
Sex	M	M	F	F	F	F	F
Age (y)	41	56	60	64	50	72	49
Ruptured an.	Y	N	N	Y	Y	Y	Y
An. Location	L MCA	BA	R MCA	R ICA	L A1	R ICA	Pericallosal
An. max diam. (mm)	23	16.4	3.2	10.6	3.1	1.9	4.9
An. neck (mm)	13	12.9	2.3	7	0.5	2.1	2.6
Shape/ thrombosis	Incorporating MCA trif.	Partially thrombosed	Saccular	Serpentine aneurysm	Blister aneurysm	Blister aneurysm	Saccular
Stent	2	1	1	1	1	1	1
FDS	2	1	0	1	1	1	0
FDS type	Silk	PED	Baby Leo	PED	PED	p64	Baby Leo
Immediate angio outcome (RR)	C	C	A	C	C	C	C
Immediate angio outcome (OKM)	B	A	NAp	B	B	NAv	NAp
Immediate angio outcome (CS)	4A	4A	NAp	4A	4A	NAv	NAp
Late angio outcome (RR)	-	C	NAv	C	A	NAv	B
Late angio outcome (OKM)	-	C	NAp	NAv	NAv	NAv	NAp
Late angio outcome (CS)	-	3	NAp	NAv	NAv	NAv	NAp
Angio modality	-	DSA	-	MRA	MRA	-	MRA
Delay late angio FU (mo)	-	13	-	10	7	-	3
Discharge mRS	6	3	0	2	1	1	1

Latest mRS	6	2	0	2	1	0	1
Delay latest mRS (mo)	6 days	13	4	10	7	6	4

nb: number; F: female; M: male; y: years; An.: aneurysm; Y: yes; N: No; L: left; R: right; MCA: middle cerebral artery; trif.: trifurcation; BA: basilar artery; ICA: internal carotid artery; A1: First segment of the anterior cerebral artery, angio.: angiographic, RR: Roy-Raymond Scale [8]; OKM: O'Kelly-Marrota grading scale [9]; CS: Cekirge-Saatci grading scale; mRS: modified Rankin scale; NAp: Not applicable; NAv: Not Available, FDS: flow diverter stent; mo: months.

Figure captions

Figure 1.
50-y-o female patient admitted for a World Federation of Neurological Surgeons (WFNS) II subarachnoid haemorrhage. **A**. CT-scanner, axial slice showed thick subarachnoid hemorrhage graded Fisher II, with no vascular cause found on primary angiogram (**B**). Control angiogram 8 days later, selective left ICA injection (**C** and **D,** black arrow) and 3D rotational angiography; volume-rendering reconstruction (**E**) showing a blister-like aneurysm of the left A1 segment. Periprocedural unsubtracted angiograms (**F** and **G**): deployment of a flow diverter stent (Pipeline Flex 2.5x10mm, Medtronic) in left A1. **H**. Control flat panel volume CT angiography with 20% contrast media dilution performed in the angio suite at the end of the procedure showing optimal coverage of aneurysmal neck and satisfactory wall apposition of the stent. Note the contrast media stagnation in the aneurysms (arrow)

Figure 2.
57-y-o male admitted in our Institution for the management of a large basilar artery aneurysm revealed by right IIIrd cranial nerve palsy. **A**. and **B**. FLAIR-weighted image, axial slice (**A**) and 3D time of flight (TOF) axial MIP reconstruction (**B**) showing a partially thrombosed aneurysm of the basilar artery with compression of the right aspect of the mesencephalon (white arrow).
CT angiography, coronal MIP reconstruction (**C**) and left vertebral artery DSA in working projection (**D**) displaying the partially thrombosed aneurysm. Unsubtracted image during the FDS deployment (Pipeline Flex 4x35 mm) from the right PCA to the basilar artery. **E**. Control flat panel volume CT angiography with 20% contrast media dilution performed in the angio suite at the end of the procedure displaying the satisfactory deployment of the FDS. At D20, the patient experienced huge headache and vertigo. Comparison between the preoperative CTA (**G**) and CT-scan at D20 (**H**) showed the appearance of a hydrocephalus, which is clearly seen on the enlargement of the IIIrd ventricle, due to increasing of the mass effect of the aneurysm's sac. After switching the ticagrelor for cangrelor, a ventriculoperitoneal drainage was placed in the right lateral ventricle, leading to improvement of hydrocephalus as displayed on the control CT-scan (**I** and **J**).