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CASE REPORT

Aortic root thrombus after left ventricular assist device implantation and aortic valve replacement

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Abstract

Data on the risk of aortic root thrombosis in patients with aortic valve replacement (AVR) and left ventricular assist device (LVAD) surgery are scarce. Two out of nine patients receiving AVR concomitant with LVAD surgery and two out of two patients receiving AVR on LVAD support, at our centre, developed an aortic root thrombus, all diagnosed with computed tomography (CT) angiography. These results demonstrate that patients with concomitant AVR and LVAD surgery, or AVR on LVAD support, have an increased risk of aortic root thrombosis. Therefore, early anti-thrombotic therapy and vigilant diagnostic follow-up, using CT scans, are warranted to prevent thromboembolic events.

Keywords Left ventricular assist device; Aortic valve replacement; Aortic root thrombosis

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Introduction

Currently, contemporary left ventricular assist devices (LVADs) utilize continuous flow, which are strongly associated with an increased risk for the development of aortic regurgitation (AR).[1] AR during LVAD support is associated with a negative impact on haemodynamics, hospitalization, and overall survival. Therefore, concomitant aortic valve (AV) replacement (AVR) is recommended in patients with moderate-to-severe AR.[2] Changes in the blood flow in the aortic root increase the risk of thromboembolic events. However, data on the risk of aortic root thrombosis and stroke after AVR concomitant with LVAD surgery are scarce. Therefore, we retrospectively reviewed all consecutive HeartMate II (HMII; n = 62) and HeartMate 3 (HM3; n = 42) implantations performed between December 2006 and December 2018 in our centre.

Case report

During this period, 11 (11%) patients received an AVR: nine concomitant during LVAD surgery, one trans-catheter AVR 337 days post-LVAD surgery, and one surgical AVR 520 days post-LVAD surgery (*Table* 1). In all patients, a computed tomography (CT) angiogram was performed to visualize the AVR position and function. After a median follow-up of 23.5 days (20.0–654.0) post-LVAD surgery, four patients (36%) were diagnosed with an aortic root thrombosis with CT angiogram (*Figure* 1). In three patients, the CT angiogram was performed during regular follow-up, while in one patient, transthoracic echocardiogram (TTE) results were suspicious for aortic root thrombosis, which was confirmed on CT angiogram. In contrast, none of the patients without an AVR were diagnosed with an aortic root thrombosis. Of the four patients diagnosed with an aortic root thrombosis, all appears to originated from the left coronary cusp but effected all the cusps and were between 3 and 5 mm in size, all preventing the AV to open. The aortic anatomy on the CT angiogram was compared between both patient groups, no differences in aortic root diameter were observed, and no aortic root pathology increasing the risk for aortic root thrombosis was identified.

No significant differences were observed in the platelet counts pre-LVAD (181.0 [157.0–211.0] vs. 167.5 [115.3–204.0], respectively, P = 0.788) and post-LVAD surgery (102.0

Table 1 Clinical features of individual patients with aortic valve replacement

	Patient										
	1	2	3	4	5	6	7	8	9	10	11
Baseline											
Age	55	52	61	52	39	24	63	65	53	56	59
Gender	Male	Male	Male	Male	Male	Male	Male	Female	Male	Male	Female
HF aetiology	DC	IC	DC	DC	DC	DC	IC	DC	DC	IC	IC
eGFR pre-LVAD, mL/min	48	24	65	49	53	33	14	38	24	49	22
ASAT pre-LVAD, U/L	25	23	47	44	19	1071	84	43	73	38	39
ALAT pre-LVAD, U/L	18	48	38	24	16	996	26	44	140	54	30
Gamma-GT pre-LVAD, U/L	67	204	139	83	66	15	97	132	100	683	48
Alkaline phosphatase pre-LVAD, U/L	41	135	112	88	102	39	177	139	144	310	127
Bilirubin pre-LVAD, μmol/L	21	8	10	51	27	43	14	43	70	27	37
MELD score pre-LVAD	22	20	15	23	20	26	30	16	28	14	29
Platelet count pre- LVAD, 10^9/L	157	182	221	170	211	93	104	149	181	186	210
INR pre-LVAD	1.9	1.2	1.8	1.9	2.0	2.0	1.6	1.6	1.8	1.2	2.9
LVAD type	HMII	HMII	HMII	HMII	HMII	HM3	HM3	HM3	HM3	HM3	HM3
LVAD indication	BTT	BTT	BTT	BTT	BTT	BTT	BTT	DT	BTC	BTT	DT
Degree of AR (0–4)	4	3	3	2	4	3	2	3	2	4	4
Post-LVAD											
Days until adequate heparin level	2	6	4	2	4	7	1	3	2	4	5
Days until introduction aspirin	11	633[a]	5	13	5	39	32	12	9	—[b]	—[c]
Platelets count post-LVAD, 10^9/L	97	113	160	102	156	52	75	62	95	119	105
Imaging											
MAP (mmHg)	—[d]	92	88	84	88	87	83	86	88	84	—[d]
LVAD speed at last TTE	9200	9000	8600	9000	9000	5300	5200	5100	5500	5300	5300
Aortic valve opens at last TTE	No	No	No	No	Minimal opening	No	No	No	No	Yes	No
ART on TTE	No	No	No	No	No	No	No	Yes (22 days post-LVAD)	No	Suspicion (26 days post-AVR)	Yes (33 days post-TAVR)
ART on CT-a	No	No	No	No	No	No	Yes (654 days post-LVAD)	Yes (20 days post-LVAD)	No	Yes (27 days post-AVR)	Yes (30 days post-TAVR)
Outcome											
Days on LVAD support	750	2163	939	1465	1359	622	564	398	167	599 (39 days with AVR)	953 (538 days with TAVR)

(*Continues*)

Table 1 (continued)

	Patient										
	1	2	3	4	5	6	7	8	9	10	11
Stroke	No	No	Haemorrhagic stroke (454 days post-LVAD)	No	No	No	No	No	No	Ischaemic stroke (24 days post-AVR)	No
	HTx	Ongoing LVAD support	HTx	Ongoing LVAD support	Ongoing LVAD support	Ongoing LVAD support	Ongoing LVAD support	Ongoing LVAD support	Ongoing LVAD support	Deceased	Ongoing LVAD support
Clinical outcome											

ALAT alanine transaminase; AR, aortic regurgitation; ASAT, aspartate aminotransferase; BTC, bridge to candidacy; BTT, bridge to transplant; CT-a, computed tomography angiogram; DC, dilated cardiomyopathy; DT, destination therapy; eGFR, estimated glomerular filtration rate; gamma-GT, gamma-glutamyl transferase; HF, heart failure; HMII, HeartMate II; HM3, HeartMate 3; HTx, heart transplantation; INR, international normalized ratio; IC, ischaemic cardiomyopathy; LVAD, left ventricular assist device; MAP, mean arterial pressure; MELD, model for end-stage liver disease; TAVR, trans-catheter aortic valve replacement; TTE, transthoracic echocardiogram.

[a]Owing to a PCI shortly prior to LVAD implantation, clopidogrel was continued instead of aspirin.

[b]Shortly after reaching a therapeutic heparin range, the patient was for another 7 days out of the therapeutic heparin range.

[c]Owing to the TAVR procedure clopidogrel was started instead of aspirin, after diagnosis of aortic root thrombus clopidogrel was continued.

[d]Blood pressure could not be measured owing to continuous-flow LVAD.

Figure 1 Computed tomography angiography showing an aortic root thrombosis on the bioprosthetic aortic valve. The arrows indicate the thrombus.

[95.0–156.0] vs. 90.0 [65.3–115.5], respectively, P = 0.648) in patients with and without an aortic root thrombosis. Additionally, none of the patients had a history of bleeding disorders or thromboembolic events, such as stroke or deep vein thrombosis.

Directly post-operatively, from Day 1 post-surgery, heparin was introduced with gradual increasing doses in both patients diagnosed with an aortic root thrombosis and those free of aortic root thrombosis. No difference was seen in the time-to-therapeutic heparin dosage between the groups: the median time of 3.5 (1.0-5.0) and 4.0 (2.0-7.0) days, respectively. In both patient groups, some patients reached a therapeutic heparin dosage owing to post-operative bleeding events leading to the temporary lowering of the heparin dosages. When patients were discharged from the intensive care unit and had no bleeding events, the intravenous heparin was switched for an oral vitamin K antagonist. Aspirin was introduced later post-LVAD surgery in patients diagnosed with an aortic root thrombosis as compared with patients free of aortic root thrombosis [median time-to-introduction of aspirin 22.0 (12.0–32.0) vs. 10.0 days (5.0–39.0), respectively]. The delayed introduction of aspirin in both groups was mainly caused by a high bleeding risk or actual bleeding events.

One patient diagnosed with an aortic root thrombosis suffered from an ischaemic stroke 24 days post-AVR. Unfortunately, this patient suffered from extensive neurological damage and passed away 39 days post-AVR. The follow-up in the other patients was without any thromboembolic events.

Discussion

The material of bioprosthetic valves is thrombogenic and activates the coagulation cascade, increasing the risk for thrombus formation in patients with an AVR.[3] Aortic root thrombosis can increase the risk of thromboembolic events, such as ischaemic stroke. Additionally, patients with an aortic root thrombosis are at risk for occlusion of the ostium of the left main coronary, especially if the thrombosis is formed in the left coronary cusp. Early introduction of antiplatelet and anticoagulation therapy is very important, because thrombi might start forming in the first 24 h after implantation[4] and remained elevated in the first 3 months.[3] The importance of the early introduction of, especially, antiplatelet (Day 1 post-implantation) along with the anticoagulation therapy is also shown in our patients, because three out of four patients developed an aortic root thrombosis shortly after AVR procedure. Additionally, minimal or lack of AV opening, owing to excessive LV unloading by the LVAD, causes a blind pouch in the aortic root, increasing the risk of thrombus formation, especially in patients who are longer on LVAD support. Ideally, LVAD speed settings are optimized, resulting in optimal LV unloading and an intermittent opening AV. However, this can be challenging, as demonstrated in our patients: optimal LVAD speed settings were determined based on clinical and TTE parameters. However, hardly any patient had an intermittent opening AV.

Three out of four patients who were diagnosed with an aortic root thrombosis had ischaemic heart disease as the underlying cause of their heart failure. It is known that patients with ischaemic heart disease have an increased risk for thrombus formation. However, whether these patients with LVAD implantation and AVR have an increased risk for aortic root thrombosis is unknown.

TTE examination is commonly used in the follow-up of LVAD patients. However, diagnosing an aortic root thrombosis on the basis of TTE images can be difficult, leading to the underdiagnosing of aortic root thrombosis. In non-LVAD patients, trans-oesophageal echocardiography and CT angiogram have shown to be superior in detecting aortic root thrombosis.[5] Similarly, the diagnosis of AV thrombosis was only made based on CT angiogram results in our patients, indicating that CT angiogram might be superior over TTE in LVAD patients with an AVR as well.

The use of anticoagulation therapy after AVR has shown to be effective in patients without an LVAD, and the International Society for Heart & Lung Transplantation recommends starting aspirin and adequate heparin therapy within 1 day post-LVAD implantation.[2] However, studies investigating the optimal timing of anticoagulation and antiplatelet therapy initiation after an AVR in LVAD patients are lacking. The current European Society of Cardiology/European Association for Cardio-Thoracic Surgery Guidelines advice for the prompt introduction of aspirin, that is, on Day 1 post-operative AVR.

Conclusions

In conclusion, LVAD patients with an AVR had an increased risk of aortic root thrombosis and probably increased risk for ischaemic stroke. To prevent these thromboembolic events, early introduction of anti-thrombotic therapy should carefully been balanced against the bleeding risk. Furthermore, vigilant diagnostic follow-up is needed for the timely diagnosis of aortic root thrombosis, potentially using CT scans, although this might increase the risk of radiation exposure. Our results are hypothesis generating and are limited by the small sample size and lack of a randomized controlled comparison between patients with and without aortic AVR. Therefore, prospective, multicentre studies are urgently needed to elucidate aortic root thrombosis after AVR and LVAD implantation and the possible risk of thromboembolic events.

Conflict of interest

None declared.

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