CASE REPORT

Pulmonary oedema, think beyond the heart even in the presence of severe left ventricular systolic dysfunction

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SUMMARY

We submit a case of a young patient with known severe left ventricular (LV) systolic impairment who presented with recurrent flash pulmonary oedema (FPO) requiring multiple high-dependency care admissions. Despite extensive optimisation of his underlying heart failure, the presentations remained frequent. Investigations for alternative diagnosis were not approached due to the presence of LV impairment and compliance being questioned. However, deteriorating renal function prompted further investigation with multiple imaging modalities, and an effective diagnosis of bilateral renal artery stenosis secondary to an aortoiliac thrombus was made. At the point of diagnosis, it was felt that rescue of renal function was unfeasible and thus the patient was started on anticoagulation, with initiation of peritoneal dialysis planned. This case highlights the importance of considering alternative diagnoses for the presentation of FPO even in the presence of LV impairment. If this patient had received a prompt diagnosis it is possible that the outcome would have been different.

BACKGROUND

Pulmonary oedema is associated with significant mortality.¹ The most common cause is cardiac in nature either in the context of an ischaemic event, poorly controlled arrhythmias or left ventricular (LV) systolic dysfunction. In these patients, up-titration of medical therapy, device therapy and referral for transplantation need to be considered if there are recurrent presentations with pulmonary oedema. However, it is important to consider alternative causes of pulmonary oedema, particularly renal artery stenosis (RAS), even in the presence of LV impairment, as without the appropriate treatment these patients will have ongoing acute presentations to hospital. Care needs to be taken in assuming lack of patient compliance to drug therapy or fluid restriction as the cause for their presentation. The recurrent admission with sudden onset shortness of breath (within hours), deranged renal function on blood test and discrepancy in renal size on ultrasound should trigger investigation for RAS.

CASE PRESENTATION

A 48-year-old man with a known diagnosis of dilated cardiomyopathy (DCM) presented on a frequent basis to hospital, with sudden onset shortness of breath secondary to pulmonary oedema. Two

years prior, at the time of diagnosis, the CMR (as part of his work up) illustrated a myopathic process with the absence of scar/fibrosis or inducible ischaemia to suggest underlying ischaemic heart disease, and an ejection fraction (EF) of 15%. Full DCM screen at that time identified no secondary cause. As the patient remained New York Heart Association (NYHA) class III despite optimal treatment, and the ECG demonstrated left bundle branch block with QRS duration of 153 ms, he underwent cardiac resynchronisation therapy defibrillator (CRT)-D implantation. He remained stable for 1 year, following which he started to present weekly to hospital, with sudden onset shortness of breath over minutes to hours, suggestive of flash pulmonary oedema (FPO). His transthoracic echocardiogram continued to demonstrate severely dilated and impaired LV with an EF of 15–20%. There was no significant valvular abnormality.

Management was made difficult by the patient presenting to different hospitals and, as a result, clinicians were not fully aware of the frequency of the admissions. However, as the hospitals shared the same electronic systems, all investigation findings were reported and all the clinicians became aware of these findings. Further to this, even though the patient presented to other hospitals, the largest proportion of his admissions were still to his local hospital. There was also a concern regarding cognitive function with a suspected diagnosis of learning difficulties, which contributed to the major concerns of compliance to medication and fluid restriction. In view of this, referral for transplantation was not approached.

The CRT interrogation demonstrated adequate biventricular pacing with an atrial fibrillation (AF) burden of 9.6%, which was managed with β -blocker therapy. The patient's CHA₂DS₂-VASc score was 1, in view of his congestive heart failure, but he was reluctant to start on oral anticoagulation therapy. Despite extensive education and heart failure optimisation, the presentations remained frequent. An alternative diagnosis was not sought in view of the LV impairment and questionable compliance. In view of the compliance issue, the patient received extensive repeated heart failure education. One year prior to the frequent admissions with pulmonary oedema, the renal function was normal, while during the initial admissions he had mildly deranged renal function (creatinine between 115–128 μ mol/L), but this was believed to be secondary to his underlying cardiac disease and

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Figure 1 Mercaptoacetyltryglycine (MAG3) renogram images. (A) The MAG3 images demonstrating the lack of uptake of the radioisotope in the left kidney compared to the right. (B) The right-sided graph demonstrating the reduced uptake of radioisotope in the left kidney compared to the right over minutes (red line—left kidney; green line—right kidney). The left-sided graph demonstrating the reduced flow rate of radioisotope in the left kidney compared to the right, this being a surrogate to renal blood flow (red line—left kidney; green line—right kidney; white line—aorta).

medications. However, with progressive deterioration in renal function (creatinine between 135–260 $\mu\text{mol/L}$) further investigations were prompted; initially with a renal ultrasound, which demonstrated discrepancy in kidney size, with the left measuring 6 cm and the right kidney, 10.3 cm, indicative of an atrophic left kidney. This finding raised the concerns of RAS.

INVESTIGATIONS

MR angiography is a non-invasive technique, capable of demonstrating renal vascular anatomy and revealing physiological information about kidney function, including blood flow rate and renal perfusion.² It has been shown to have sensitivity and specificity equivalent to invasive angiography.^{3–4} It further avoids the need for contrast and thereby minimises the risk of contrast-induced nephropathy. However, this was contraindicated in our patient due to the implanted MR-incompatible device. In view of this device and to avoid contrast exposure, he underwent a mercaptoacetyltryglycine (MAG3) renogram with diuretic to allow a functional assessment of both kidneys and to exclude obstructive uropathy. MAG3 renograms can ensure a physiological assessment of renal blood flow and function through evaluating the uptake of the radioisotope, technetium-99 m MAG3.^{5–6} With the addition of the diuretic injection, the clearance of the radioisotope can be evaluated to exclude obstruction. In our patient, this MAG3 scan demonstrated a lack of radioisotope uptake and poor renal blood flow

in the left kidney compared to the right. This was indicative of an atrophic left kidney with poor renal function and thereby highly suggestive of severe left-sided RAS (figure 1).

Following this, the patient underwent a CT renal angiogram to get a detailed anatomical assessment of the renal arteries. CT renal angiograms are alternative imaging modalities in these patients; they have shown similar accuracy to invasive angiography in RAS of $\geq 50\%$, with high sensitivity and specificity.⁷ Their use is restricted because of the risk of contrast nephropathy and exposure to ionising radiation. The CT renal angiogram in this patient demonstrated thrombotic occlusion of the abdominal aorta just above the origin of the renal arteries extending downstream to the bifurcation of the iliac arteries (figure 2A). There was subtotal occlusion of the left renal artery with reduced contrast opacification of the left kidney (figure 2B). Although patent, the right renal artery was likely stenosed, as it was supplied through a very minute channel within the aortic thrombus. These findings confirmed the presence of bilateral RAS.

OUTCOME AND FOLLOW-UP

The case was extensively discussed and it was felt that rescue of renal function and prevention of pulmonary oedema would not be feasible through either revascularisation via percutaneous stenting or surgery. Thus the patient was started on anticoagulation therapy and peritoneal dialysis was initiated. Had a prompt diagnosis been available, perhaps medical staff would

Figure 2 Axial CT renal angiogram images. (A) Thrombotic occlusion of the aorta (red arrow). (B) Atrophic and partially occluded left renal artery (red arrow) resulting in some contrast opacification of the upper pole of the left kidney (yellow arrow).

have been able to see past the severe LV impairment and consider a wider differential, altering this patient's outcome. During a 6-month follow-up period, the patient had had significantly fewer admissions to hospital. Further CT imaging importantly demonstrated no extension of the thrombus with some reduction in its size.

DISCUSSION

Our patient presented with sudden onset pulmonary oedema (min/h) and experienced rapid resolution with treatment, which is indicative of FPO.⁸ Without triggering factors of arrhythmia or ischaemia, which was not the case in our patient, this is not a common presentation of decompensated LV dysfunction presenting more progressively over days or weeks. Other identified causes for FPO include hypertension, valvular heart disease, end-stage renal failure and RAS, particularly bilateral.⁸ Our patient had no clinical or echocardiographic evidence of significant valvular heart disease. He was also persistently normotensive. The estimated GFR indicated that he did not have end-stage renal failure. With repeated admissions despite treatment, RAS became a more likely diagnosis and ultimately this was confirmed with an effective combination of complementary imaging modalities.

RAS is a narrowing of the renal arteries, commonly secondary to atherosclerotic disease in adults.⁹ In our patient, RAS was secondary to an aortoiliac thrombus, of which this is the first reported case of its kind in the literature. It is possible that the underlying paroxysmal AF precipitated the thrombus formation, as AF is a well-recognised cause of thromboembolism.¹⁰ It is therefore possible that initiation of anticoagulation therapy might have prevented this, however, our patient was not keen to

start on anticoagulation. FPO is a known presentation of RAS,¹¹ with a reported prevalence of around 15.3%.¹² This is more common in bilateral RAS,¹² which was the case in our patient.

Studies have demonstrated that revascularisation of haemodynamically significant RAS decreases the frequency of pulmonary oedema and heart failure hospitalisation.^{13–14} However, other studies have disputed benefits by demonstrating no reduction in cardiovascular events and all-cause mortality.¹⁵ Therefore the decision for stenting of RAS should be made on a case-specific basis. In our patient, it was felt that revascularisation would not be beneficial neither in preventing hospitalisation with pulmonary oedema nor in rescuing renal function; in view of this, the patient was started on renal replacement therapy.

Contributors All the authors were involved in the management of the patient. SH wrote the first draft of the case report. MC, AD and FF contributed by editing the first draft and writing the consequent drafts.

Competing interests None declared.

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Learning points

- First, it emphasises the importance of optimised medical therapy in left ventricular (LV) dysfunction, and of education in targeted fluid and salt restriction, and underscores the fact that advanced therapies such as biventricular devices and transplantation should be considered.
- Second, it further highlights that even in severe LV dysfunction, recurrent presentations of pulmonary oedema despite therapy should prompt further evaluation, and warrants a high index of suspicion for alternative diagnoses such as renal artery stenosis (RAS).
- Care should always be taken prior to assuming that compliance constitutes a major role for the patient's presentation.
- It is also important to identify alternative diagnostic tests when certain modalities are not feasible and to understand what the limitations are of each tool.
- Last, the case shows that MRI, mercaptoacetyltriglycine renogram and CT angiogram can be used in different combinations to provide sensitive and specific complementary information in the diagnosis of RAS.

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