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LETTER TO THE EDITOR

Treatment of a Hepatic Artery Aneurysm by Endovascular Exclusion Using the Multilayer Cardiatis Stent

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Introduction

The Cardiatis Multilayer stent (Cardiatis, Isnes, Belgium) is a cobalt self-expandable bare stent that has been available and approved for peripheral aneurysm management in European countries since May 2009. This stent consists of a three-dimensional braided tube made of two interconnected layers without any covering. The unique quality of this device is that it decreases flow velocity within the aneurysm vortex while improving laminar flow in the main artery and surrounding vital branches. This allows a pressure decrease within the aneurismal sac, stasis, and the formation of an organized thrombus.

The Cardiatis Multilayer stent has been applied in experimental studies across aneurysms in many anatomic locations, including cerebral, aortic, and peripheral aneurysms. However, there are no publications in the literature describing multilayer implantation in the hepatic artery.

The Cardiatis Multilayer stent is available in diameters ranging from 5 to 12 mm and lengths ranging from 30 to 120 mm. They use sheaths from 6F to 7F and require a 0.020-inch guidewire.

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Case Report

A 74 year-old man was incidentally found to have an 85-mm hepatic artery aneurysm during an abdominal ultrasound for urinary outflow symptoms. The patient was immediately sent to the Emergency Department. Clinical examination showed a palpable, pulsatile mesogastric mass with normal lower-limb pulse. The patient had no pain, and there were no signs of aneurysm rupture.

Subsequent investigation with computed tomographic angiography (CTA) confirmed the presence of a saccular aneurysm (85-mm maximal diameter) at the origin of the common hepatic artery, involving the proper hepatic artery distal to the gastroduodenal origin (Fig. 1). This saccular aneurysm, which was also studied on a computed tomography workstation, had a large neck (32 mm) arising from the parent vessel (common hepatic artery) and involved the common hepatic ostium with a virtual proximal neck with splenic artery (Fig. 1A). The gastroduodenal artery arose from the sac, and there was a short distal neck with hepatic artery bifurcation (Figs. 1B–D). After discussing the case in the vascular multidisciplinary team meeting, surgical repair was considered to be high risk because of the patient's comorbitities. Therefore, considering the characteristics of the aneurysm, we decided to treat it using a new kind of device, the Cardiatis Multilayer stent.

Because of the high risk of spontaneous rupture, an aggressive approach was mandatory. Digital subtraction angiography (DSA) (Fig. 2A) was performed using the right femoral approach. We used a 45 cm-long, 6F-wide sheath, a shepherd hook catheter (Cordis, Miami, FL), and a 0.035-inch hydrophilic guidewire (Terumo, Tokyo, Japan) to engage the celiac trunk and the hepatic artery distal to the aneurysm. After pushing the catheter to the distal portion of the right hepatic artery, we exchanged the

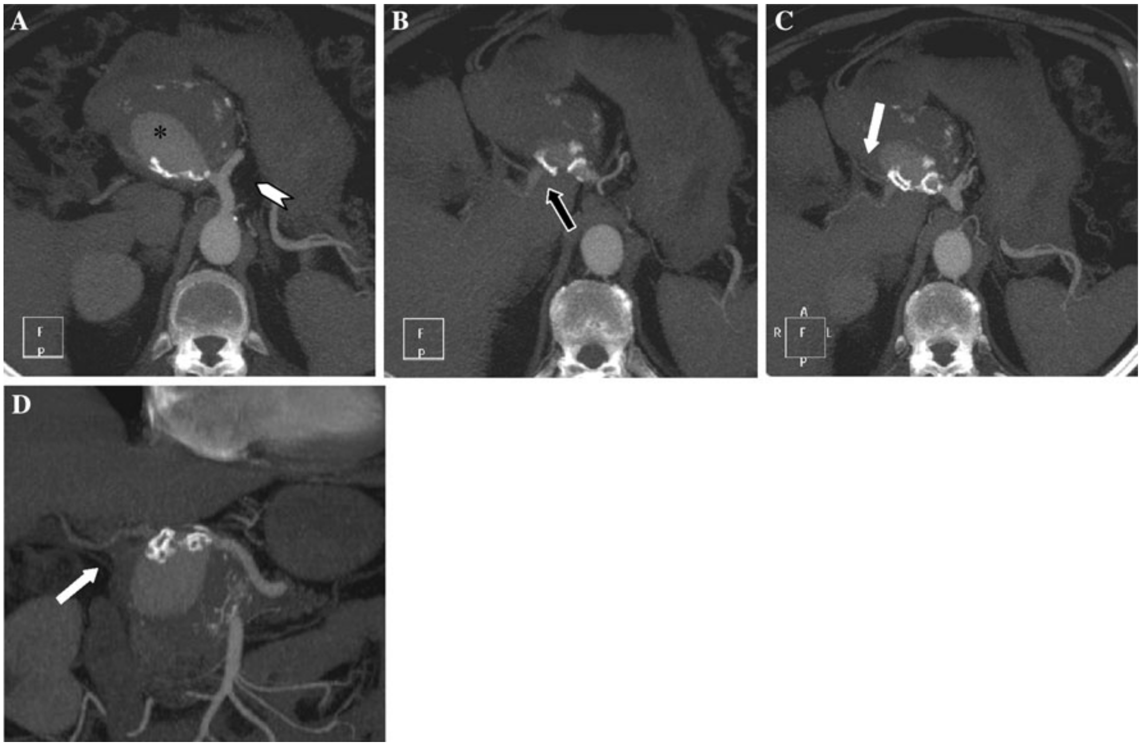

Fig. 1 CTA scan (maximal intensity projection [MIP]) showing a large aneurysm (*) of common hepatic artery and a virtual neck with the splenic artery (*white head arrow*) (**A**) and short neck with proper hepatic bifurcation (*black arrow*) (**B**). Axial and coronal images shows gastroduodenal artery emergence from aneurysm (*white arrow*) (**C**, **D**)

0.035-inch wire for a 0.020-inch wire (PTA Steerable; Boston Scientific, Natick, MA). Finally, we deployed a multilayer stent (8 × 60 mm) to bridge the aneurismal lesion covering the splenic, gastroduodenal and left hepatic arteries (Fig. 2B, C).

Subsequent DSA demonstrated a flow decrease with initial thrombosis of the sac and indicated the regular patency of the stent and of splenic, left gastric, left hepatic, and gastroduodenal arteries (Fig. 2D, E).

Oversizing by 1 mm, as recommended by the manufacturer, was considered appropriate. The hepatic artery measured 7 mm; therefore, an 8 mm–wide stent was used. Hemostasis was obtained with an Angioseal device (St. Jude Medical, Zavatem, Belgium).

A global clinical laboratory examination was performed after the endovascular procedure and showed no alteration of hepatic functionality. Plasma levels of conventional liver function enzymes were normal, and there were no significant symptoms of hepatic, gastric or splenic ischemia. Before discharge, Doppler ultrasound (US) showed right perfusion of liver and spleen.

CTA performed 6 months later showed complete thrombosis of the aneurysm sac and regular patency of the stent (Fig. 3A) and the hepatic (Fig. 3B, 3C), splenic (Fig. 3D), and gastroduodenal (Fig. 3C) arteries (Fig. 4); there was initial shrinking of the sac (Fig. 5). There was no change in size or morphology of the aneurysm, and there were no signs of splenic ischemia.

Discussion

Many of the cases reported in literature are either anecdotal or based on collective reports.

In general, intervention is recommended when the aneurysm is symptomatic or when there is a high risk of rupture [5, 7]. We consider a size of 85 mm to be at high risk for rupture.

In the literature, traditional open surgical management is indicated for common hepatic aneurysms involving the proper hepatic artery [6].

A case report by Jaunoo et al. [4] described a similar common hepatic aneurysm involving the origins of hepatic, gastroduodenal, left, and right gastric arteries. The investigators considered endovascular treatment not feasible and treated it surgically.

Instead, our patient was elderly and had an American Society of Anesthesiologists score of 3. Furthermore, the risk of sac rupture during laparotomy was high, especially in this large aneurysm. Endovascular management seemed to be the correct option for this patient. In the literature, several endovascular treatment options have been

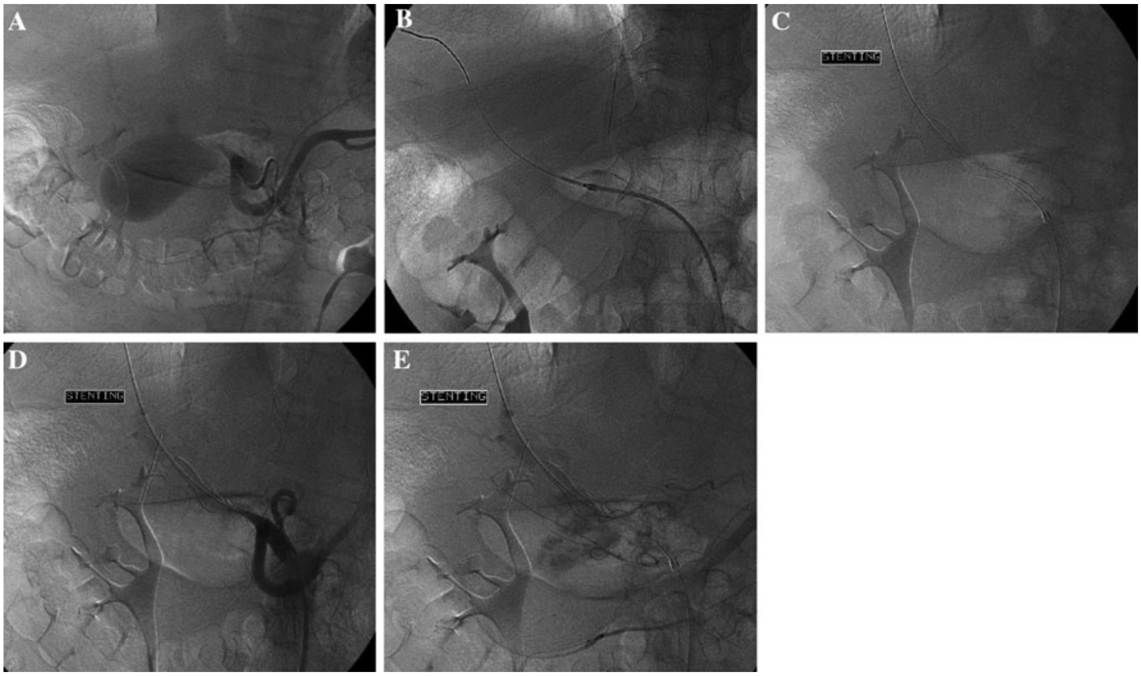

Fig. 2 DSA confirms the large hepatic artery aneurysm (**A**) and shows stent implantation (**B**, **C**). Poststenting angiogram shows exclusion of the aneurysm with an important decrease of blood flow velocity inside the aneurysmal sac (**D**, **E**)

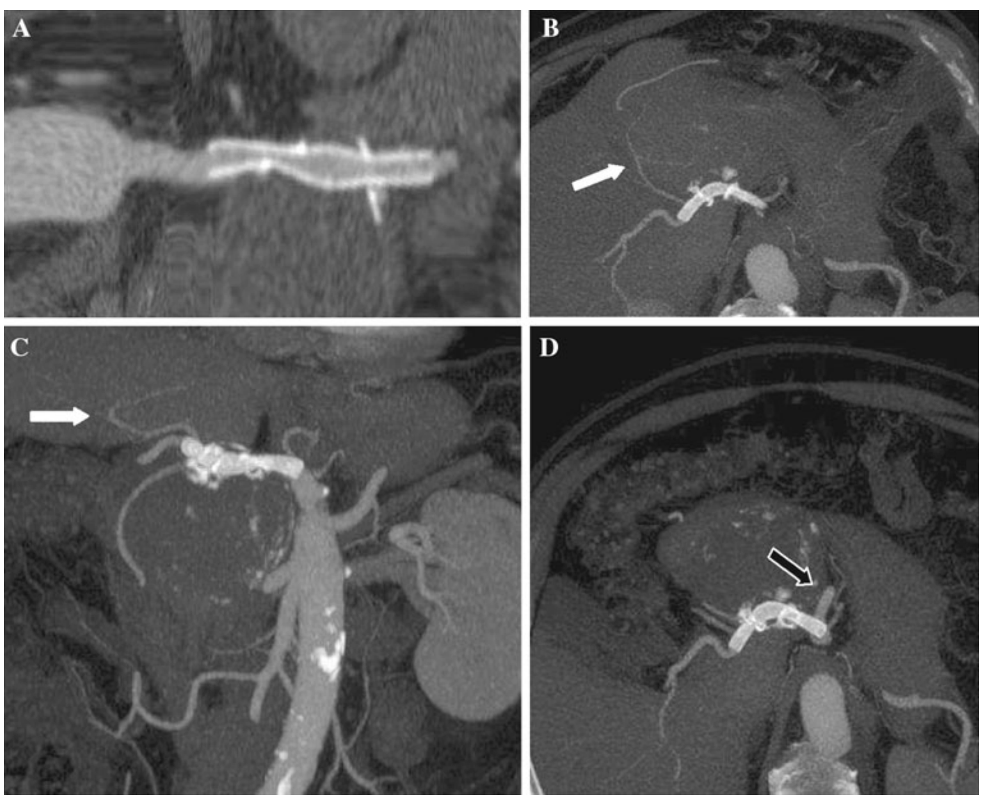

Fig. 3 CTA (MIP) scan shows complete exclusion of the aneurysmal sac (hyperdensity of the sac are parietal calcification) and regular patency of the stent (**A**), the left hepatic artery (*white arrow*) (**B**, **C**), the gastroduodenal artery (*white arrow*) (**C**) and the splenic artery (*black arrow*) (**D**)

Fig. 4 CTA scans (volume rendering) (**A**) before and (**B**) 6 months after endovascular management show the results of treatment: thrombosis of the sac, patency of the stent, and patency of the gastroduodenal [*white arrow* in (**B**)], left hepatic [*white arrowhead* in (**B**)], and splenic arteries [*curved arrow* in (**B**)]

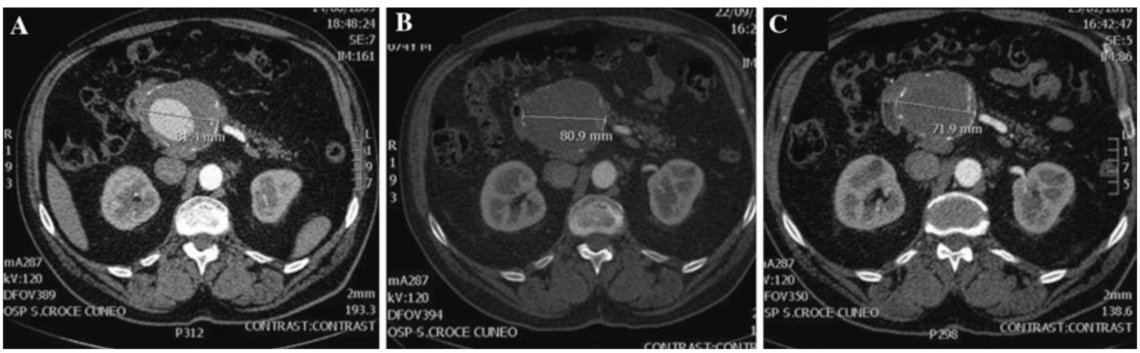

Fig. 5 Shrinking of the aneurysm. Initial CTA (**A**), follow-up CTA at 1 month (**B**), and follow-up CTA at 6 months (**C**) show progressive decrease of the aneurysm sac from 81.4 to 71.9 mm

described depending on the aneurysm's features. Embolization of the artery is the accepted treatment of choice for intrahepatic aneurysms [4–7], but it is not indicated for extrahepatic aneurysms. Endovascular repair using stent graft has been described [1, 2, 5–7], but in our case its deployment could have been challenging due to the high profile and large sheath required. Although in the literature occlusion of visceral vessels generally does not involve major complications [6], in our case report, CTA showed that there was short proximal neck to the splenic artery and to the proper hepatic bifurcation, not enough to place a covered stent graft without compromising the origin of the splenic, gastroduodenal, and left hepatic arteries.

Another endovascular option was to fill the aneurysmal sac with coils, but there was a large neck with the common hepatic artery, and the risk of coil migration with occlusion of vital branches was high; although the vena porta and its branches were patent, the risk of hepatic ischemia was real.

Combined endovascular management using both bare stent and coils would have probably not completely excluded the sac, leading to increased risk of leak, and appeared redundant.

The Cardiatis Multilayer stent is a new kind of self-expandable stent with two interconnected layers without any covering. As described in animals studies and in experimental studies in humans [8, 9], this new stent allow allows the exclusion of aneurysms from circulation while preserving collaterals. In literature, we found only one case report in which a Cardiatis Multilayer stent was implanted: Polydorou et al. described the successful exclusion of a renal complex aneurysm using a multilayer stent [3].

Given the characteristics of the Cardiatis Multilayer stent (low profile and 6F sheath) and the morphology of the aneurysm, we decided to implant this stent in our patient. Postoperative angiogram showed an important decrease in blood flow velocity in the sac with initial thrombosis. It also showed that the side branches remained patent. The patient was discharged 2 days after the procedure.

Six months later, follow-up CTA showed correct exclusion of the aneurismal sac without any images of leaks. The stent and vital branches remained patent, with initial shrinking of the sac (from 85 to 71 mm).

The capacity to exclude an aneurysm while maintaining distal perfusion and patency of branches in a single step appears to make the Cardiatis Multilayer stent the ideal therapeutic choice, especially in visceral aneurysms, in which there often is a short landing zone and frequent bifurcations. Moreover, the relatively low profile of this device, particularly when compared with traditional covered stent grafts, allows the engagement of even tortuous vessels.

Multilayer stents open up great scenarios, providing interventionalists with the opportunity to treating complex visceral and peripheral aneurysms percutaneously. In the future, it is likely that such an approach will be reasonably offered to treat the majority of visceral aneurysms. The only disadvantage of the Multilayer stent is its high cost. Clearly, clinical trials should be undertaken to confirm our initial experience, and further investigation is warranted to understand the patency of the Cardiatis Multilayer stent.

Conflict of interest statement The authors declare that they have no conflict of interest.

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