

The MANTA Vascular Closure Device for Percutaneous Femoral Vessel Cannulation in Minimally Invasive Surgical Mitral Valve Repair

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Abstract

A 65-year-old Caucasian male was referred to our institution with severe mitral regurgitation due to posterior mitral leaflet prolapse. The patient underwent minimally invasive surgical mitral valve repair. Here we present the application of a new vascular closure device (MANTA) for percutaneous arterial access and closure.

Keywords

MANTA, vascular closure device, minimally invasive, mitral valve, femoral cannulation

Introduction

Vascular closure devices (VCDs) are widely used to achieve hemostasis after procedures requiring percutaneous common femoral artery (CFA) puncture.¹ Transfemoral transcatheter valve implantations require 14 to 18 Fr femoral artery access and a number of devices have been developed to facilitate percutaneous vascular closure.² Percutaneous femoral vessel cannulation for minimally invasive mitral valve surgery potentially avoids complications associated with a surgical cutdown (such as infection or lymphoma) but is prone to the same variety of access-related complications seen with transcatheter devices (such as bleeding complications). The percutaneous arterial access for arterial cannulation in minimally invasive mitral valve surgery can be closed safely with a new VCD (MANTA, Essential Medical Inc., Malvern, PA, USA).

Case Report

A 65-year-old man was transferred to our institution with symptoms of fatigue, palpitations, and dyspnea. Echocardiography revealed severe mitral valve regurgitation due to prolapse of the posterior leaflet (Fig. 1). As depicted in Figure 2, preprocedural planning using 3-dimensional reconstructions from computed tomography (CT) angiography showed suitable vessel size and absence of calcification allowing for safe percutaneous femoral cannulation using the MANTA Vascular Closure Device (Teleflex, Wayne, PA, USA). The patient was scheduled for minimally invasive surgical

mitral valve repair (MIS MVR) through a periareolar approach as described in detail elsewhere.^{3–5} Endoaortic balloon occlusion was planned, and bilateral radial arterial catheters were placed to monitor potential distal balloon migration. Infrainguinal puncture of the left CFA was performed before venous cannulation to avoid arterial puncture under systemic heparinization (Fig. 3a). A guidewire was introduced and the correct position was verified in the descending aorta with transesophageal echocardiography (TEE). Heparin was administered. Blunt dissection of the subcutaneous tissue all the way down to the femoral artery with a mosquito clamp was used to allow smooth introduction of the cannulas for cardiopulmonary bypass (CPB; Fig. 3b). After successful access, the initial 6 F sheath was exchanged for the MANTA puncture location

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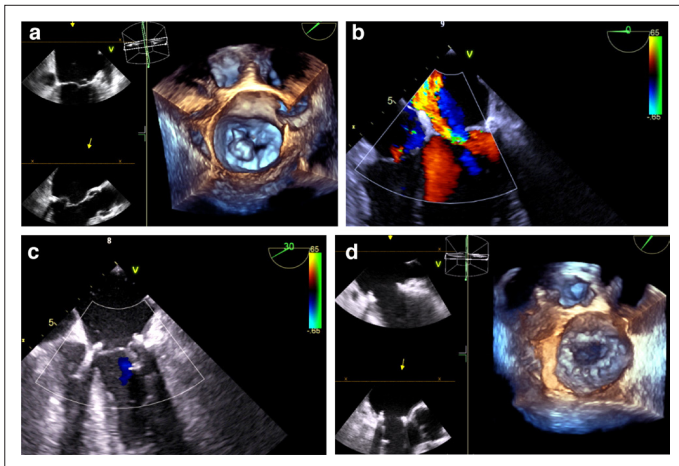


Fig. 1. Preoperative transesophageal echocardiography of the mitral valve before surgical repair in 3D (a) and in 2D with Doppler (b) showing prolapse of the posterior mitral leaflet resulting in mitral regurgitation and an eccentric jet. Postoperative transesophageal echocardiography of the repaired mitral valve after surgery in 2D with Doppler (c) and in 3D (d) showing no residual mitral regurgitation. 2D, 2-dimensional; 3D, 3-dimensional.

dilator to measure the distance from the arteriotomy to the skin level (Fig. 3c). The subcutaneous track from skin level to the endoluminal arterial space (in this case 5.5 cm) was measured

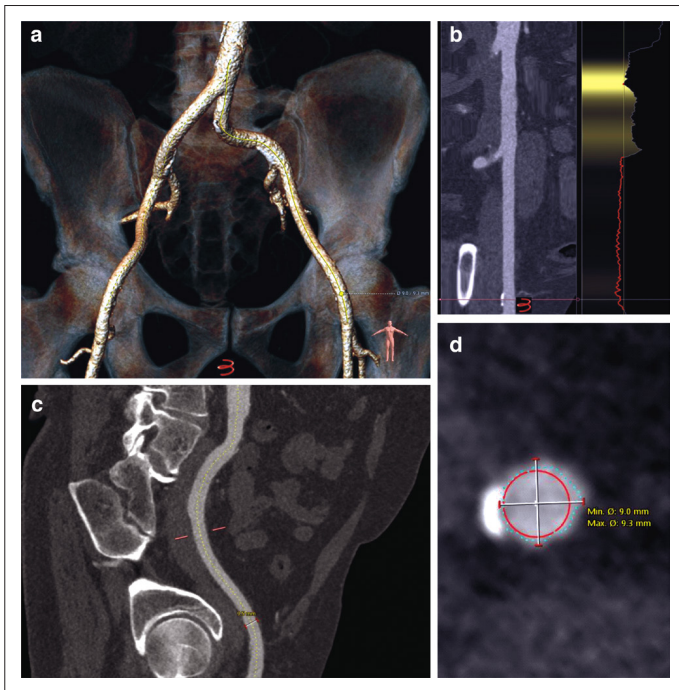


Fig. 2. Preoperative computed tomography angiography scans and reconstructions for percutaneous femoral cannulation access planning. (a) Three-dimensional reconstruction of the lower abdominal aorta, the iliac and femoral arteries. (b) Stretched reconstruction [snake view]. (c) Sagittal view of left iliac and femoral arteries. (d) Minimum and maximum diameter measurements of the left common femoral artery puncture site.

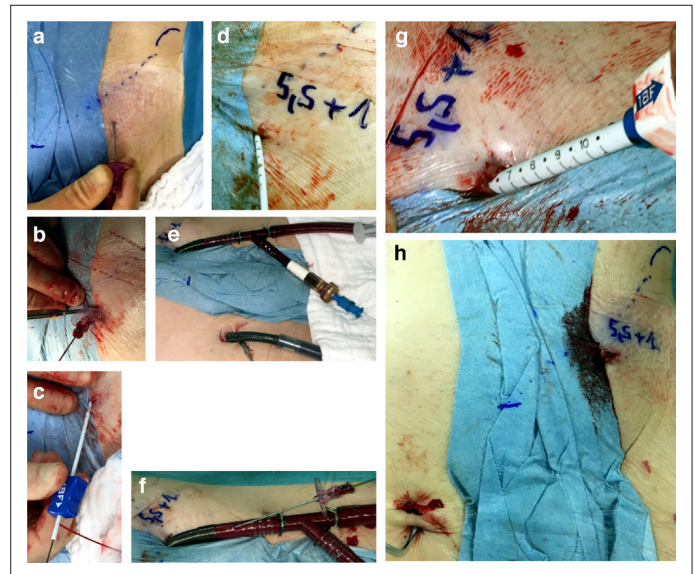


Fig. 3. (a) Infrainguinal puncture of the anterior wall of the mid common left femoral artery. (b) Incision and blunt dissection of the subcutaneous tissue all the way down to the femoral artery with a mosquito clamp. (c) After confirmation of successful and uncomplicated access, the initial 6 F sheath was exchanged for the MANTA puncture location dilator to measure the distance from the arteriotomy to the skin level. (d) Distance from skin level to the endoluminal arterial space [in this case report 5.5 cm]. (e) 23 F arterial cannula (EndoReturn Arterial Cannula, Edwards Lifesciences) for percutaneous arterial perfusion during CPB and a venous cannula (Smartcanula, LLC, Lausanne, Switzerland) in the right common femoral vein. (f, g) Prior to arterial decannulation, the CPB tubing is punctured with a needle and a guidewire is brought into the femoral artery. Then, the arterial cannula was exchanged for the dedicated MANTA sheath to deploy the device. The MANTA sheath-closure unit is withdrawn up to the predetermined deployment level. The toggle is released and the unit is withdrawn from the patient. Pulling force can be monitored by the color code of the tension gage. The blue tamper tube emerges and is advanced along the suture line to secure the stainless-steel lock onto the vessel and further compact the collagen pad. (h) Final result after application of the MANTA device. CPB, cardiopulmonary bypass.

(Fig. 3d). Subsequently, a 23 F arterial cannula (EndoReturn Arterial Cannula, Edwards Lifesciences) was inserted for percutaneous arterial perfusion during CPB (Fig. 3e). TEE then confirmed optimal placement of the tip of the venous cannula (Smartcanula, LLC, Lausanne, Switzerland) in the superior vena cava after percutaneous placement via the right common femoral vein. Vacuum-assisted venous drainage was used with maximum of 30 mmHg throughout the procedure. Through the periareolar incision, a soft-tissue retractor (Alexis S) was used without additional rib-spreading to enter the fourth intercostal space (ICS). The procedure was performed endoscopically using a 10-mm 3-dimensional 30° scope in the fourth ICS lateral to the working port (Aesculap Einstein 3.0). The right hemi-diaphragm was retracted caudally with a suture placed in the tendinous dome and brought out by a suture hook through a stab incision in the right sixth ICS. The pericardium was opened

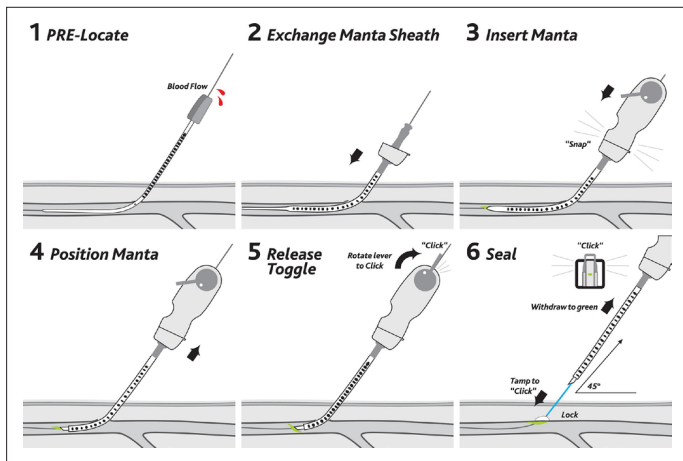


Fig. 4. Schematic diagram representing the instructions on how to use the MANTA device correctly and safely.

3 to 4 cm anterior and parallel to the phrenic nerve from the proximal ascending aorta to the diaphragm. The surgical field was flooded with carbon dioxide through the camera port. After standard endoaortic balloon occlusion under TEE visualization, antegrade single-dose cardioplegia was administered. After opening of the roof of the left atrium, the mitral valve was repaired using a 30-mm Physioring (Carpentier-Edwards Physio II Annuloplasty Ring, Edwards Lifesciences), 18 mm premeasured Gore-Tex chordal loops, and closure of a posterior mitral leaflet cleft (P1 region). After cessation of CPB the arterial cannula was exchanged for the dedicated MANTA sheath to receive the MANTA closure unit as shown in Figure 3f. The assembled MANTA sheath-closure unit was

withdrawn up to the predetermined deployment level (+1 cm to be added to the initial measurement). The toggle was released and the unit was withdrawn from the patient (Fig. 3g). Pulling force can be monitored by the color code of the tension gage. The blue tamper tube emerged and was advanced along the suture line to secure the stainless-steel lock onto the vessel and further compact the collagen pad. The suture was cut above the tamper and at skin level (Fig. 3h). Figure 4 represents a schematic diagram showing the 6 different phases of correct and safe deployment of the MANTA device. The MANTA system basically is a polymer component (toggle) attached to a collagen plug and a delivery system used to place the toggle-collagen plug implant. The operation time was 179 minutes; CPB and aortic cross-clamping-times were 99 and 54 minutes, respectively. Immediately after the procedure, vascular ultrasonographic calculation of the left CFA blood flow velocity interval showed a normal blood flow pattern distal to the MANTA device implantation site (Fig. 5). Absence of an increased systolic rise time and no loss of pulsatility were demonstrated (Fig. 5). Angiography of the femoral access and cannulation site were performed before and after cannulation (Fig. 6).

Discussion

The introduction of VCDs has had a tremendous impact on the evolution of transcatheter interventions and has facilitated percutaneous femoral cannulation for minimally invasive cardiac surgery. VCDs have shown a significant reduction in discomfort and an improvement in hemostasis and ambulation after both diagnostic and therapeutic percutaneous procedures.⁶ In a retrospective observational study, Pozzi et al. analyzed a single-center series of 300 consecutive MIS MVR patients the with the Prostar vascular occlusion device.⁷ It was concluded that

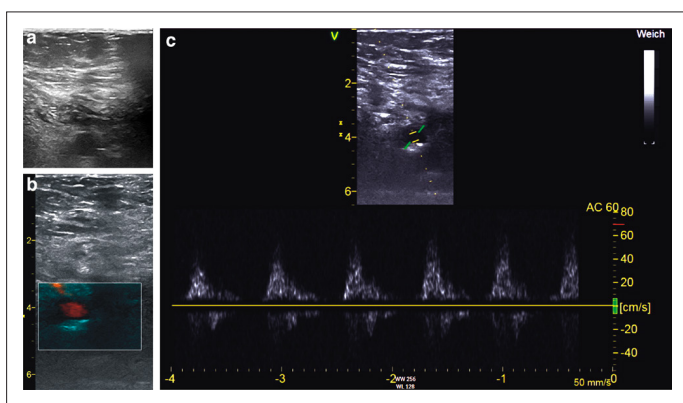


Fig. 5. (a) Ultrasonographic visualization of the left CFA before puncture at the beginning of the procedure. (b) Color Doppler 2-dimensional ultrasonographic check of laminar blood flow through the left CFA after application of the MANTA device at the end of the procedure. (c) Vascular ultrasonographic calculation of the left CFA blood flow velocity interval showing a normal blood flow pattern distal to the MANTA device implantation site at the end of the procedure. Absence of an increased systolic rise time and no loss of pulsatility are shown. CFA, common femoral artery.

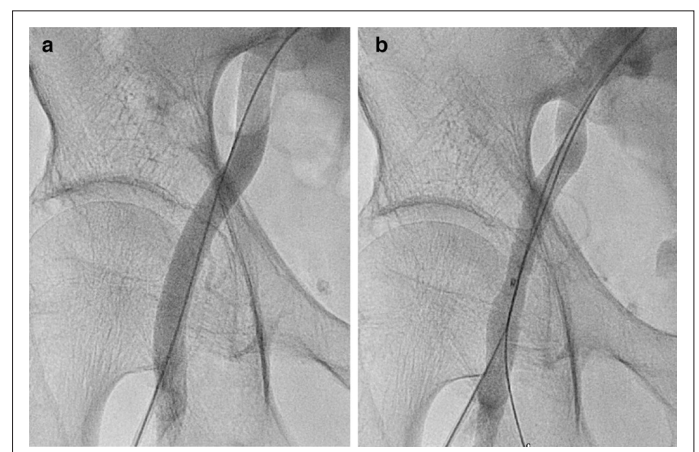


Fig. 6. Angiography showing the comparison of femoral arterial flow and anatomy precannulation and before MANTA device application (a) versus femoral arterial flow and anatomy postcannulation and after deployment of the MANTA device (b). The small black radiopaque marker in (b) represents the MANTA plug on the anterior outer side of the femoral vessel wall.

the percutaneous femoral vessel cannulation technique is particularly suitable for MIS MVR cases with a high success rate and few complications. Similar results may be expected with the use of the MANTA device. With the advent of the percutaneous approach, the potential complications of the traditional groin incision might be less with fewer groin infections, hematoma, or lymphocele. Nevertheless, one has to take into account that unlike in TAVR and (T)EVAR no angiographic control of the cannulation site is performed. We, therefore, recommend the use of ultrasound to confirm (1) vessel patency, (2) absence of flow obstruction, and (3) absence of hematoma. When considering the use of a VCD, surgeons must be aware of the various predictors of vascular complications reported in the literature.⁸ Some commonly reported risk factors for vascular complications include the following: age >70 years, female sex, body surface area <1.6 m², duration, complexity, and emergent procedures are also associated with poor outcomes.⁸ Finally, there is increased risk of vascular complications in patients with renal failure, peripheral vascular disease, hypertension, and congestive heart failure.⁸⁻¹¹ Additionally, VCD instructions for use carry numerous cautions including femoral artery size less than 4 mm, obesity, and inflammatory disease. A preoperative CT scan or a limited femoral angiogram can be helpful to assess vessel size as well as to confirm proper access-site location above the femoral bifurcation. Regardless of the device type, deployment failure can be another drawback of VCDs. The decision to use a VCD rests in the operator domain where integration of clinical data and familiarity with a particular closure device plays a key role in achieving successful hemostasis and avoiding access-site complications.¹² In case of failure of MANTA device deployment, one could perform a control angiography, and if there is still residual bleeding or vessel stenosis, one should contemplate surgical cutdown.

Declaration of Conflicting Interests

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Supplemental Material

Supplemental material for this article is available online.

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