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Ajmer Singh *

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Case Report

Tip-to-Base LAMPOON Procedure for a Valve-in-Valve Transcatheter Mitral Valve Replacement

Ajmer Singh *, Ravina Mukati

Cardiac Anaesthesia Medanta-The Medicity, Gurugram (Haryana)-122001, India

***Corresponding Author:** Ajmer Singh, Cardiac Anaesthesia Medanta-The Medicity, Gurugram (Haryana)-122001, India

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Abstract

Left ventricular outflow tract obstruction is a life-threatening complication of transcatheter mitral valve replacement caused by septal displacement of the anterior mitral leaflet. This complication can be avoided by using of a new technique, called LAMPOON or Laceration of Anterior Mitral leaflet to Prevent left ventricular Outflow ObstructioN. LAMPOON procedure involves splitting the anterior mitral leaflet just before transcatheter mitral valve replacement, which would otherwise be displaced anteriorly by the mitral valve implant and cause left ventricular outflow obstruction. In this case report, we discuss our initial experience with the tip-to-base LAMPOON technique to prevent left ventricular outflow obstruction.

Keywords: lampoon procedure, transcatheter mitral valve replacement, valve-in-valve, transesophageal echocardiography

Introduction

Transcatheter mitral valve replacement (TMVR) is an established technique to treat mitral valve dysfunction in patients with diseased native mitral valve, bioprosthetic valve, or after ring-annuloplasty, who are at a prohibitive surgical risk.1 TMVR can potentially cause left ventricular outflow (LVOT) obstruction by displacing the anterior mitral leaflet (AML) towards the interventricular septum. The incidence of LVOT obstruction in TMVR occurs in up to 10–40% of valve-in-mitral annular calcification, 5% of valve-in-ring, and 0.7–2% of valve-in-valve cases.2 The patients with acute aortomitral plane angulation, long or redundant AML, small left ventricles, unfavorable left ventricular geometry, prominent septal bulge, and narrow leaflet-to-septum distance are at a higher risk of developing LVOT obstruction.3 As an alternative to alcohol septal ablation or surgical resection of AML, a new transcatheter technique to prevent LVOT obstruction has been proposed.

The new technique is called 'Laceration of the Anterior Mitral leaflet to Prevent left ventricular Outflow ObstructioN' or LAMPOON procedure. In humans, the LAMPOON procedure was first described by Babaliaros et al in 2017.4 Using simple catheter techniques, we can split the AML which otherwise would be displaced anteriorly by the mitral valve implant and cause LVOT obstruction. The procedure uses an electrified guidewire that traverses the aorta retrogradely towards the leaflet base or tip, depending on the technique used; and which then is pulled outward toward the left atrium. This causes a split of the AML, which no longer obstructs the LVOT after transcatheter heart valve (THV) implantation.

The technique involves two important steps: leaflet traversal and leaflet laceration. The leaflet traversal consists of the insertion of dual retrograde catheters: one from the left atrium and the other from the aorta and LVOT. The laceration entails traction on both ends of the guidewire that has crossed the AML during electrification. The tip-to-base laceration technique obviates the need for traversing and can be used in patients with prior bioprosthetic valves or mitral rings.

In this case report, we describe our initial experience with this technique to prevent LVOT obstruction.

Case Report

A 72-year-old female, who had undergone bioprosthetic MVR (SJM Biocor® valve, St Jude Medical, Inc. St Paul, Minnesota, USA) in 2013 was admitted for recurrent heart failure due to degenerated bioprosthesis. The echocardiographic evaluation showed severe mitral stenosis (transvalvular gradient 34/14 mmHg), severe mitral regurgitation, severe tricuspid regurgitation, and pulmonary artery systolic pressure 55 mmHg **(Figure 1**). Preoperative computed tomography (CT) and its 3D reconstruction predicted LVOT obstruction due to small left ventricular cavity and unfavorable aortomitral angle. The predicted neo-LVOT area using virtual 27.5 mm Myval was calculated and found to be 133 mm2(**Figure 2).** The heart team decided to perform LAMPOON followed by TMVR, and informed consent was obtained.

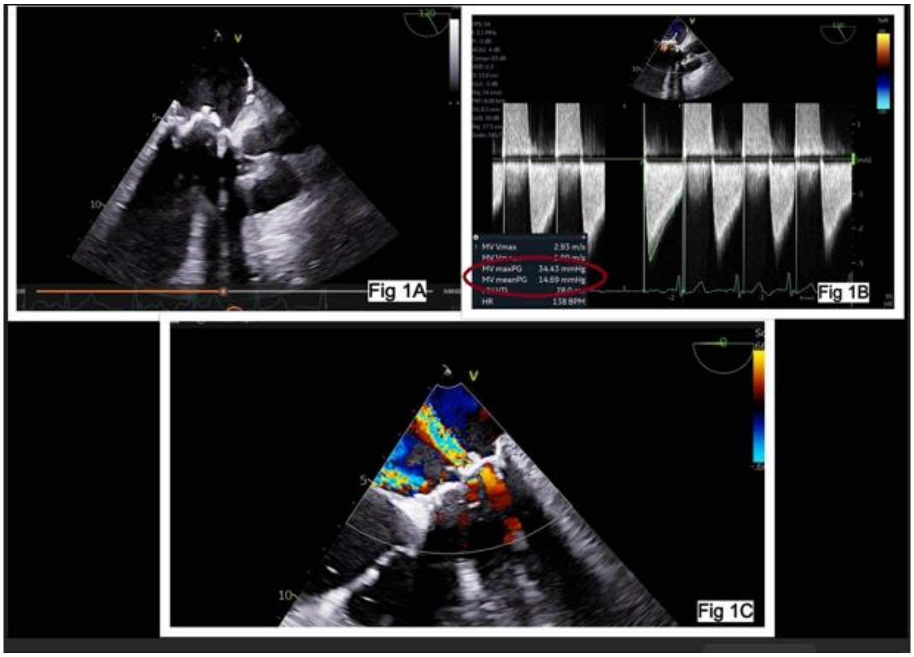

Figure 1: Transesophageal echocardiography showing degenerated bioprosthetic valve (Fig 1A) with severe mitral stenosis (Fig 1B) and severe mitral regurgitation (Fig 1C)

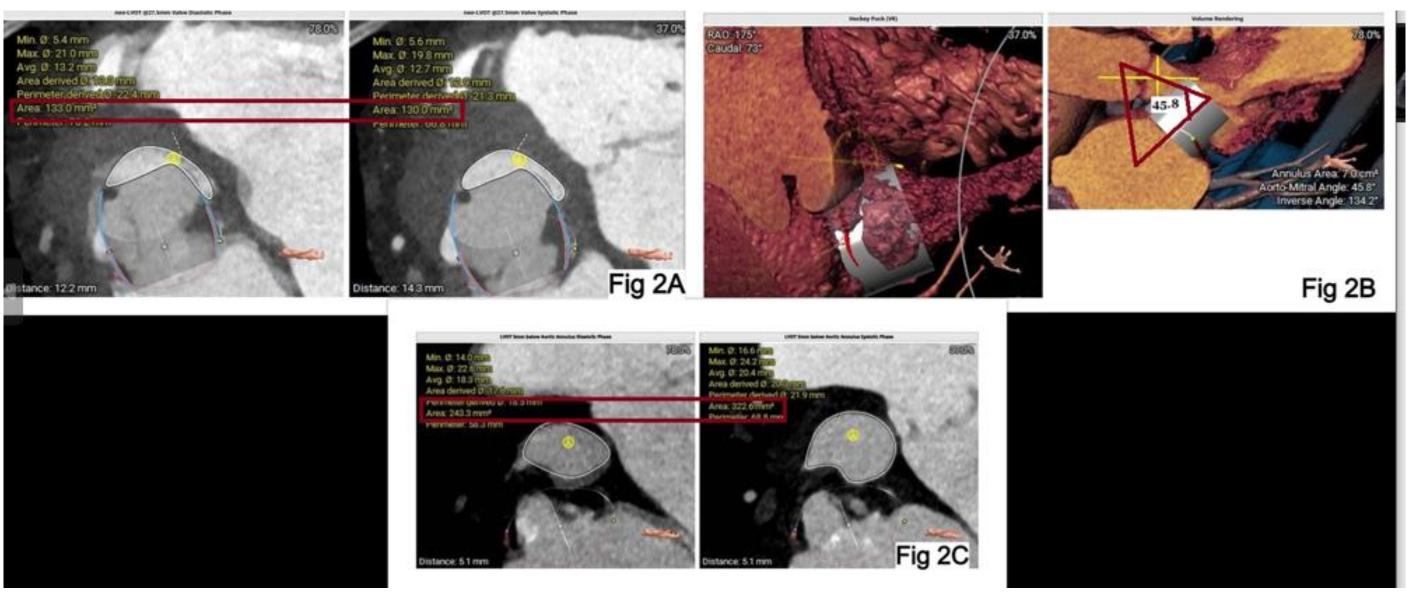

Figure 2: Dynamic computed tomography (CT) showing predicted neo-left ventricular outflow tract (LVOT) area of 130 mm2 (Fig 2A), volume rendered CT showing unfavorable aortomitral angle (Fig 2B), and predicted neo-LVOT area after deployment of the valve (Fig 2C)

The procedure was performed in the hybrid operating room using standard cardiac monitoring including 3-dimensional transesophageal echocardiography (TEE: VividTM 95, GE Healthcare System, Horten, Norway) under general anesthesia. The right femoral vein was accessed to insert a steerable sheath (Agilis NxT) and subsequently perform TMVR. After TEE-guided infero-posterior transseptal puncture, a balloon wedge end-hole catheter was advanced in the left atrium **(Figure3).** A 0.035 Terumo guidewire was advanced through the balloon catheter, snared in the aorta, and the first venoarterial loop was created. A 6F guiding catheter was inserted through the femoral artery over the wire loop and advanced into the Agilis sheath. A stiff 0.014-inch guidewire (Astato XS 20, Asahi-Intecc, Nagoya, Japan) was inserted from the venous side into the Agilis sheath and then advanced into the 6F guiding catheter inside the Agilis sheath and the second venoarterial loop was created. The Astato guidewire was positioned at the anterior leaflet's tip, with its outside end connected to monopolar cautery. The 'flying V' seg¬ment of the Astato guidewire was pulled toward the mitral valve and electrified at 70 W with continuous 5% dextrose flush to displace blood until it reached the base **(Figure 4**). For laceration, tension was applied to both limbs of the guidewire and two guiding catheters. TEE confirmed tip-to-base laceration of the mitral leaflet. The flying V reached a hard stop at the valve sewing ring. The LAMPOON system was disassembled, and the deflectable sheath in the left atrium was used to guide a stiff pre-shaped 0.035" guidewire into the left ventricle for valve-in-valve TMVR (27.5 mm Myval, Meril Life Sciences Pvt Ltd, Vapi, Gujarat, India, **Figure 4).** Post-procedure TEE showed normal functioning of the THV with a transvalvular gradient of 6/3 mmHg with no mitral regurgitation (Video 1), mild tricuspid regurgitation, no evidence of LVOT obstruction, and a normal aortic valve **(Figure 5**).

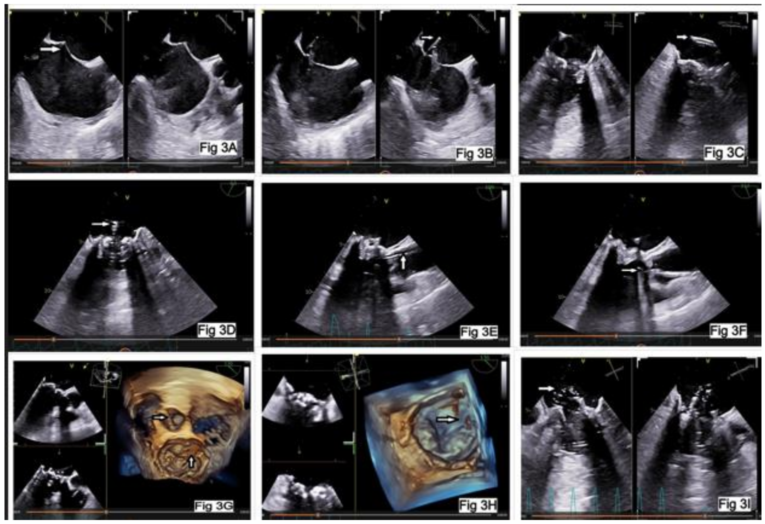

Figure 3: Steps of LAMPOON procedure: transseptal puncture, insertion of the steerable sheath and end-hole catheter (Fig 3A-C), creation of venoarterial loop (Fig 3D-G), laceration of anterior leaflet (Fig 3H), and implantation of the transcatheter mitral valve (Fig 3I)

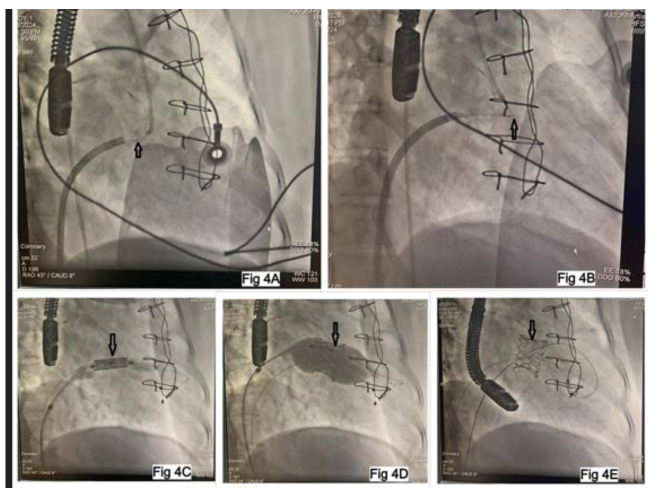

Figure 4: Fluoroscopic images showing the creation of venoarterial loop and 'flying V' guidewire straddling the anterior mitral leaflet (arrows, Fig 4A-B) and deployment of the transcatheter mitral valve (Fig 4C-E)

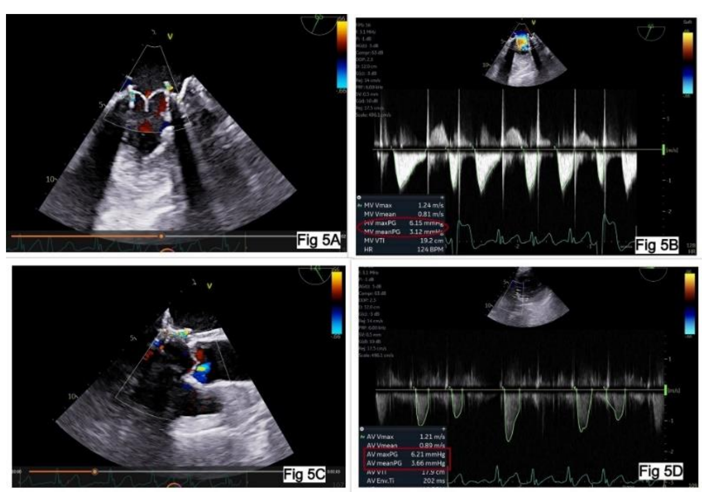

Figure 5: Post-procedure echocardiographic images demonstrating normal functioning of the transcatheter mitral valve (Fig 5A-B) and native aortic valve (Fig 5C-D)

Discussion:

LVOT obstruction, caused by displacement of prosthetic valve or native AML, is considered clinically significant when the LVOT gradient exceeds 30 mmHg. The “Fixed obstruction” or the geometric obstruction is caused by a narrowed and elongated neo-LVOT, which in turn results from the AML being pushed towards the interventricular septum from the THV. The “Dynamic obstruction” results from the systolic anterior motion of the AML towards the interventricular septum during systole, due to Bernoulli forces generated by the neo-LVOT. Fixed obstruction can be predicted by calculating a neo-LVOT on CT reconstruction. The neo-LVOT is the smallest cross-sectional area circumscribed by the THV and the interventricular septum, and it also contributes to the post-procedural LVOT gradient. The neo-LVOT can be predicted on multi-slice cardiac CT imaging by simulating a virtual THV and measuring the projected minimal cross-sectional area. Observational studies suggest that a neo-LVOT area of less than 170–190 mm2 confers an increased risk of LVOT obstruction.5 In the case described here, the projected neo-LVOT area using a virtual valve was found to be 130 mm2 which indicated an increased risk of LVOT obstruction.

LAMPOON is similar to the surgical technique of resection of the AML to prevent LVOT obstruction. The split AML parts away from the LVOT and blood flow is maintained through the open cells of the THV. Furthermore, the technique spares the subvalvular apparatus and preserves left ventricular function. Without LAMPOON, the clinicians may be compelled to implant THV higher into the left atrium with the potential risk of embolization. During the procedure, the AML is split down the midline using focused radiofrequency energy directed by catheters and guidewires. There are several modifications of the LAMPOON technique described in the literature, each appropriate in different settings.6 The various modifications are (i) retrograde classic, (ii) antegrade (iii) tip-to-base, and (iv) rescue technique. We used the tip-to-base technique, which is preferred in patients who have an aortomitral curtain protected by a complete bioprosthetic ring or a bioprosthetic mitral valve sewing ring. The major advantage of the tip-to-base LAMPOON is the elimination of the leaflet traversal step and hence its simplicity. The midline leaflet laceration must be performed by aligning the flying V on the target A2 scallop in the caudal left anterior oblique projection and by confirming alignment on simultaneous biplane TEE. It appears to be an effective technique to prevent LVOT obstruction for patients with high-risk anatomy, undergoing valve-in-valve or valve-in-ring TMVR. The potential drawbacks involved include insufficient laceration of the leaflet and inadvertent laceration of adjacent structures such as the aortomitral curtain or the aorta. These complications can be avoided by careful insulation of the electrified guidewire. Lisko et al have advocated the use of gentle traction on the electrified guidewires to avoid aortic injuries.7 In their series of 21 patients, 2 patients with aortic injury required emergency aortic valve replacement. Other complications such as injury to the transverse sinus, pericardial effusion, entanglement with chordae, and leaflet draping over the prosthetic valve, are seen less commonly with tip-to-base technique compared to other techniques.

In conclusion, the LAMPOON procedure has a promising role in therapy for patients with prohibitive surgical risk and who have a risk of developing LVOT obstruction with TMVR. Serious complications can be prevented by intraoperative TEE and fluoroscopic guidance and safe electrosurgical practice.

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