Electrosurgery in Structural Heart Interventions

Ajoe John Kattoor, MD, FSCAI[a,*], Vijay Iyer, MD, PhD[b]

KEYWORDS

• Electrosurgery • Structural cardiology • Procedural techniques • Transcaval access • LAMPOON • Patient outcomes

KEY POINTS

- Emergence of Electrosurgery: Electrosurgery stands out as a groundbreaking tool in structural cardiac interventions, transforming the management of complex cardiac conditions with its innovative approach.
- Core Procedures Highlighted: This review spotlights 5 key electrosurgical procedures—Transcaval Access, BASILICA, LAMPOON, ELASTIC/ELASTA-Clip, and SESAME—integral to complex structural interventions, showcasing their pivotal role in advancing cardiac care.
- Promise and Challenges: While these procedures exhibit promising outcomes, understanding their technical nuances, patient selection criteria, and the imperative for further research underscores the multifaceted considerations inherent in their application.
- Advancements in Cardiac Care: As technology progresses and more data accumulates, electrosurgery is poised to perpetuate its influence on cardiac care, offering minimally invasive alternatives and continually enhancing patient outcomes in complex structural interventions.
- Shaping the Landscape: With its transformative potential, electrosurgery is reshaping the landscape of cardiac intervention, epitomizing a paradigm shift toward enhanced precision, efficacy, and patient-centered care in structural cardiology.

INTRODUCTION

Electrosurgery has emerged as a valuable tool in the realm of structural cardiac interventions, offering innovative solutions to previously formidable challenges. It has enabled percutaneous tissue laceration techniques that were once exclusively performed through invasive open surgery. In this review, we delve into the fundamental principles, techniques, outcomes, and potential pitfalls of electrosurgery procedures in the context of structural cardiology. We shine a spotlight on 5 key procedures made possible by the advancements in electrosurgical techniques: Transcaval Access, BASILICA, LAMPOON, ELASTIC/ELASTA-CLIP, and the novel SESAME procedure. Together, these procedures represent the cutting-edge applications of electrosurgery in the ever-evolving field of cardiac care.

PRINCIPLE OF ELECTROSURGERY PROCEDURE

Charge concentration achieved through the transmission of radiofrequency alternating current through a guidewire to the target tissue can generate heat, boil the water inside the cells of the tissue, and vaporize it.[1] To achieve a charge concentration effective for cutting,

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[a] Division of Cardiovascular Medicine, Northwest Health, La Porte and Porter, IN, USA; [b] Division of Cardiovascular Medicine, Department of Medicine, Jacobs School of Medicine and Biomedical Sciences, University at Buffalo, Buffalo, NY, USA
* Corresponding author. 1331 State Street #140, La Porte, IN 46350.
E-mail addresses: ajoe.johnkattoor@nwhealthin.com; kattoorajoe@gmail.com

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insulation is necessary everywhere except at the contact point. Therefore, the guidewires are insulated by using microcatheters and guide catheters. Charge dispersal into the blood must be avoided to prevent coagulation and charring. This is achieved by displacing blood and flooding the electrosurgery site with a 5% dextrose nonionic solution.[2]

For traversing tissue in electrosurgery procedures, a high tip load, core to tip, coronary guidewire with no polymer jacket at the tip, such as an Astato XS 20 (Asahi Intecc, Japan), 300 cm is used. The distal end of the wire is denuded with a scalpel and connected to the electrosurgery pencil with a hemostatic forceps. The guidewire is insulated except at the tip with a microcatheter, typically a Piggyback wire converter (Teleflex, NC). The tip is positioned to be in contact with the target tissue, after which brief electrical energy is applied for 2s, at 50W 'pure cut' mode.[2]

To achieve laceration, the Piggyback microcatheter is retracted. Then a 2-3 mm section of the guidewire's midshaft is meticulously stripped of its outer layer using a scalpel blade. The scalpel's blunt tip serves as a pivot point to create a bend in the exposed segment, resulting in a precise inner curve devoid of insulation. This modified configuration, known as the "Flying V," is designed to channel the electrical current precisely onto the intended target tissue (Fig. 1). The Piggyback wire converter is then advanced to the tip of 'Flying V' leaving a 1 mm gap for current transmission. Flying V is advanced to the intended laceration site and strategically positioned between 2 guiding catheters, which help direct the laceration procedure. Electrical energy is applied at 70W 'pure cut' mode while flooding the site with 5% dextrose solution through the guide catheters and tensing both limbs of the catheter guidewire system, resulting in laceration of the tissue. Care must be taken to avoid excessive traction force, as it may cause mechanical avulsion rather than laceration.[1]

TRANSCAVAL ACCESS

Large bore access is required for transcatheter aortic valve replacement (TAVR), mechanical support devices, and thoracic endovascular aortic repair (TEVAR). However, these are not viable options when severe ilio-femoral disease is present. This condition is observed in approximately 4.7% of patients undergoing TAVR and 30% of those undergoing TEVAR.[3,4] Consequently, when feasible, transcaval access, involves obtaining large bore arterial access by accessing the femoral vein, followed by accessing the infrarenal aorta through the inferior vena cava.

Principle and Procedure

Using a preprocedure computed tomography (CT) scan, a calcium free zone in the right infrarenal aorta toward the IVC with a suitable landing zone (in case covered stent deployment is needed for bailout), is selected. The optimal projection angle and height of crossing are mapped to the lumbar vertebrae for reference.[2] In emergencies for mechanical circulatory support, simultaneous venogram and aortogram are performed with 2 pigtail catheters to obtain optimal projection angles and feasibility. After obtaining femoral veinous and small-bore arterial access, an Internal Mammary guide catheter is positioned in the IVC. Traversal to the infrarenal aorta is performed using the electrosurgery technique to cross an 0.014″ Astato guidewire into the infrarenal aorta. The wire is snared using a prepositioned snare advanced from the arterial access. Subsequently, it is exchanged for a Lunderquist guidewire (Cook Medical, IN) with the assistance of a Piggyback wire converter (to upsize to 0.035″) and a 0.035″ microcatheter. A large bore sheath is then advanced over the Lunderquist guidewire (Fig. 2). The access site is closed by using an Amplatzer Duct Occluder (ADO, 12/10/8 mm depending on the access site size). An Agilis sheath is advanced through the transfemoral venous access sheath accompanied by a 0.014″ buddy wire for safety in the event of failed closure. After deploying the aortic side of ADO, the system is withdrawn and the steerable agilis sheath is flexed to position the aortic disc flush against the aortic wall at the access site. Aortography is performed to confirm the position in which the device is released. A final angiogram is then obtained. In the event of continued extravasation, balloon aortic tamponade and covered stent deployment are performed.

Outcomes

In the NHLBI Transcaval TAVR trial which involved 100 prospective patients, transcaval access was successful in 99% of subjects. However, there was a 4% mortality rate, and 7% experienced life threatening bleeding.[5] No late bleeding associated with transcaval access was observed at 1 year.[6]

Afana and colleagues described a case series of 10 patients who underwent successful emergency placement of the Impella 5.0 device placement through transcaval access due to

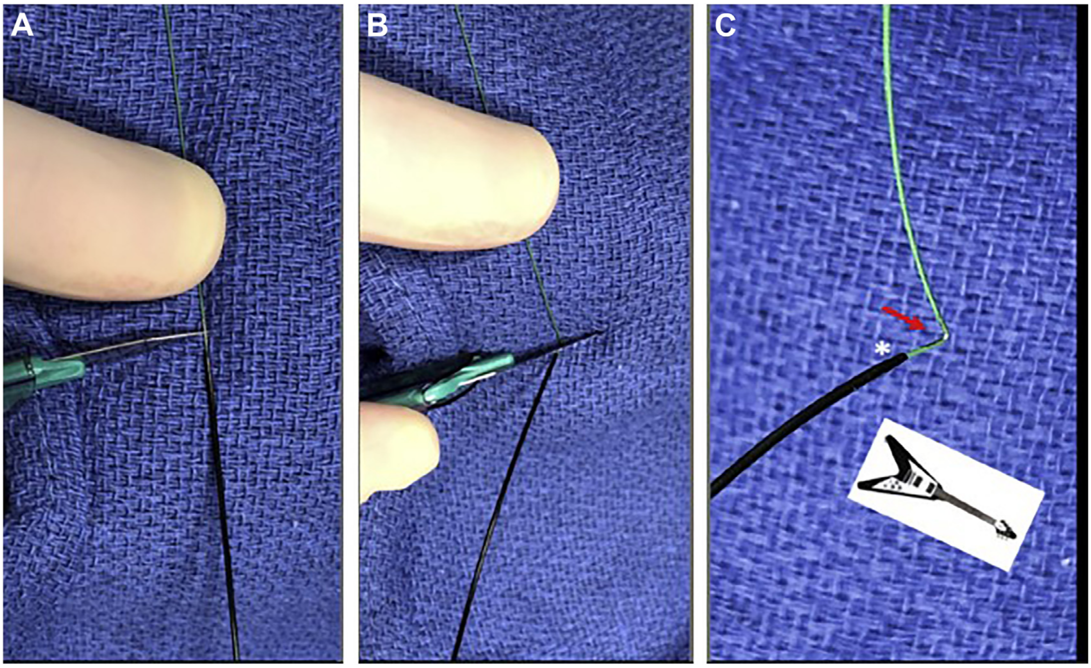

Fig. 1. Formation of 'Flying V': (*A*) Initiate the process of removing the polymer cover of the guidewire by a scraping a small portion (approximately 2–3 mm), just distal to the securely fastened Piggyback. Ensure that this removal is carried out in a non-circumferential manner. (*B*) Following the removal, utilize the blunt end of a scalpel to introduce a bend in the guidewire. (*C*) The non-circumferential denudation of the inner surface (as indicated by the *arrow*) near the Piggyback results in the creation of a distinct V-shaped structure. This specialized configuration plays a pivotal role in facilitating the electrosurgical laceration. *Piggyback wire convertor. (Robert J. Lederman, Preventing Coronary Obstruction During Transcatheter Aortic Valve Replacement: From Computed Tomography to BASILICA, JACC: Cardiovascular Interventions, 12 (13), 2019, 1197-1216, https://doi.org/10.1016/j.jcin.2019.04.052.)

cardiogenic shock. 70% of patients survived to device explant and 60% survived access port closure and were discharged.[7]

Pitfalls

Transcaval access is not feasible for all patients and depends on the patient anatomy for suitability. Complete closure of the transcaval tract was only achieved in 36% of subjects with the ADO device. Life threatening or major bleeding was noted in 12% of patients, and persistent left to right shunting is poorly tolerated by many patients with right ventricular dysfunction.[8] Dedicated devices for transcaval access closure are in development and are anticipated to improve the safety of this promising technique.[8]

BASILICA

Coronary artery obstruction occurs in approximately 0.7% of all transcatheter aortic valve replacement (TAVR) cases and 2.3% of valve-in-valve TAVR cases, and it has a high mortality rate of up to 50%.[9] It can be caused by various factors including the sequestration of the sinus of the Valsalva, direct obstruction due to a displaced leaflet of the native or bioprosthetic valve, and embolization of the thrombus or other degenerative material from the TAVR skirt or commissural posts.[10] Patients at risk of such obstructions post-TAVR have several management options, such as surgical valve replacement, palliative management, or interventional methods like the traditional Chimney-Snorkel technique or the BASILICA (Bioprosthetic or native Aortic Scallop Intentional Laceration to prevent Coronary Artery obstruction) procedure, which involves electrosurgical laceration of the aortic scallop.

To prevent obstruction of coronaries following the deployment of the TAVR valve, the conventional method involves the preventive insertion of a guidewire and stent in the coronary area perceived to be at risk. If there is obstruction in the coronary after placing the TAVR valve, the stent is then placed in the coronary artery ostium and extended into the aorta. Nevertheless, complications can arise; the stent

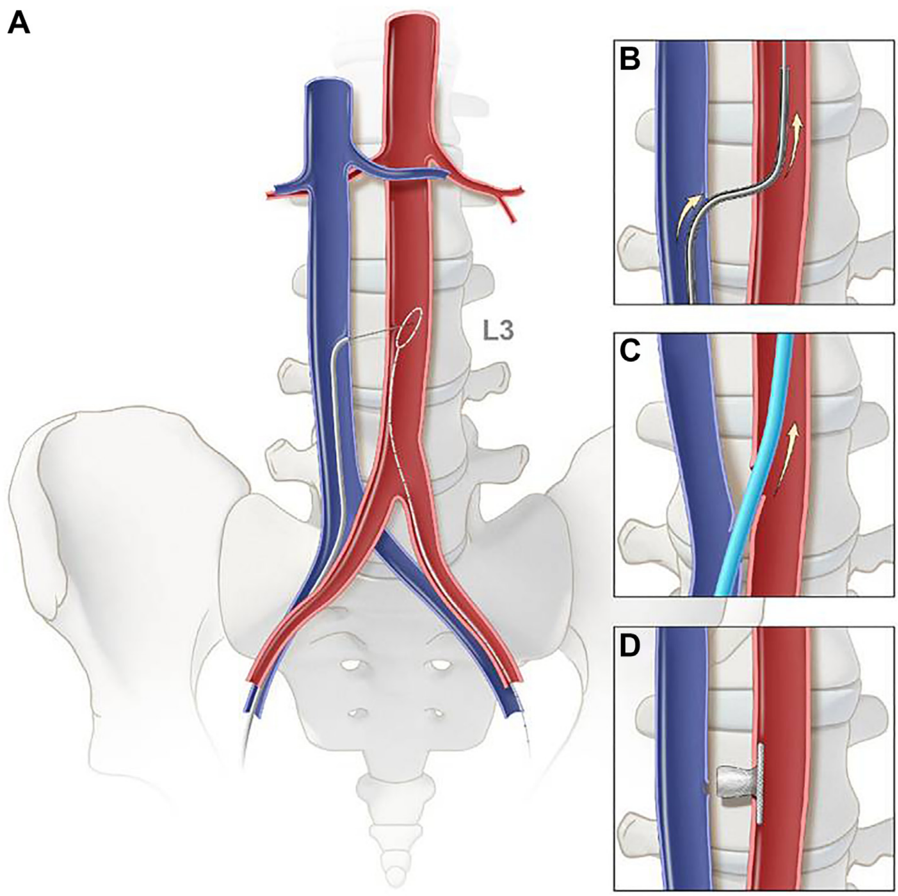

Fig. 2. Transcaval Access procedure. (*A*) An electrified guidewire is advanced from a guide located in the inferior vena cava (IVC) to a snare positioned in the infrarenal aorta. (*B*) Sequential microcatheters are progressively introduced into the aorta while countertraction is applied with the snare after which a Lunderquist wire is advanced (*C*) The large sheath is then inserted over the Lunderquist wire (*D*) Closure of the aortotomy is achieved using a nitinol mesh device. (Jaffar M. Khan, et al., Use of Electrosurgery in Interventional Cardiology, Interventional Cardiology Clinics, 11 (3), 2022, 257-266, https://doi.org/10.1016/j.iccl.2022.01.004.)

and catheter may be trapped between the TAVR valve and the aortic root, necessitating deployment irrespective of the presence of coronary obstruction to avoid detachment from the balloon. The stent can also experience issues such as cyclic compression and irregular flow dynamics around the 'snorkeled' stent, potentially leading to deformation and thrombosis of the stent. Moreover, accessing coronaries through snorkeled stent can pose significant challenges in the future.[10,11] Orthotopic stent placement through the TAVR valve cells is an alternative and is believed to avert the deformation of the stent and mitigate abnormal flow conditions that might arise with the conventional snorkel technique.[12] The BASILICA procedure is designed to address the limitations of the traditional approach, aiming to offer more enduring results by preventing coronary obstruction and, if necessary, allowing for orthotopic stent placement.

Principle and Procedure

The BASILICA procedure involves the intentional laceration of the native or bioprosthetic aortic leaflet using electrosurgery to splay the leaflet open after TAVR valve implantation, thereby allowing flow into the coronaries through the TAVR valve cells (Fig. 3). Accurate prediction of coronary obstruction post-TAVR is difficult even with CT evaluation. The best predictors for coronary obstruction post-TAVR were noted to be cusp height > coronary height, AND VTC ≤4 mm OR culprit leaflet calcium volume >600 mm^3.[13] Coronary obstruction is more common in stented bioprosthesis with externally mounted leaflets and stentless bioprosthesis when compared with stented

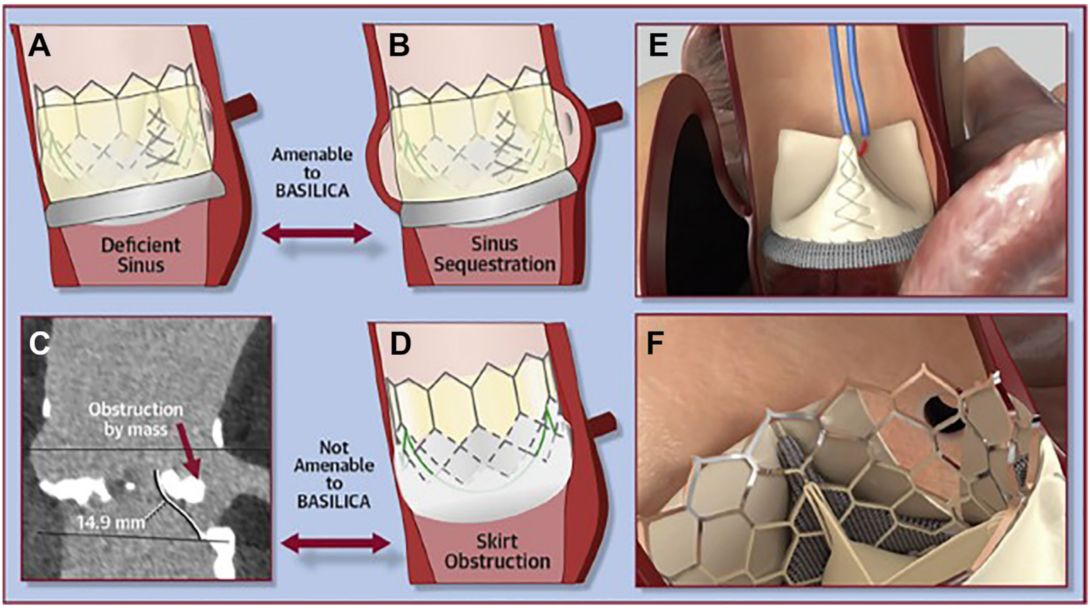

Fig. 3. Mechanisms and Mitigation of Coronary Obstruction During Transcatheter Aortic Valve Replacement (TAVR) with Bioprosthetic or Native Aortic Scallop Intentional Laceration to Prevent Coronary Artery Obstruction (BASILICA). (*A*) TAVR-induced outward displacement of aortic valve leaflets can lead to direct obstruction of the coronary artery ostium in cases where the patient has a deficient sinus of Valsalva. (*B*) The displaced aortic valve leaflets indirectly cause coronary ostium obstruction by sequesetering the sinus. (*C*) Direct coronary ostia obstruction can occur due to the presence of a bulky leaflet mass or calcium. (*D*) Coronary artery ostium obstruction may result from a fabric-covered frame or skirt, especially in cases with low coronary ostia. (*E*) In the BASILICA procedure, an electrified guidewire is employed to create intentional lacerations in the pre-existing aortic valve leaflets. (*F*) Following the BASILICA procedure, the TAVR implant serves to spread apart the lacerated leaflets, ensuring unimpeded blood flow into the potentially at-risk coronary ostium. (Robert J. Lederman, Preventing Coronary Obstruction During Transcatheter Aortic Valve Replacement: From Computed Tomography to BASILICA, JACC: Cardiovascular Interventions, 12 (13), 2019, 1197-1216, https://doi.org/10.1016/j.jcin.2019.04.052.)

bioprothesis with internally mounted valve leaflets.[9] Additionally, implantation characteristics such as depth of implantation, canting angle, TAVR device rotational alignment and TAVR device flaring–many of which cannot be easily controlled during implantation–can affect the risk for coronary obstruction.[14]

The BASILICA procedure is typically performed under general anesthesia using transesophageal echocardiography (TEE) and fluoroscopy for guidance. After obtaining large bore arterial access, the stenosed aortic valve is crossed in a typical fashion, and a JR4 or multipurpose catheter is placed in the left ventricle. A gooseneck snare is positioned through this catheter in the left ventricular outflow tract (LVOT). A second guide catheter/traversal guide catheter is then introduced either through the same access or a second arterial access. This catheter is positioned to be in contact at the mid-base of the selected leaflet and point toward the LVOT. Pachyderm-shaped guiding catheters (PAL1, PAL2, PAL3, Launcher for left) and PJR4 (for right coronary cusp) can significantly reduce the leaflet time-to-traversal during the BASILICA procedure. Otherwise, coaxial catheter pairs or an oversized catheter such as AL2, AL3, AL4, for the left and MP for the right can be selected.

A stiff conductive guidewire (typically an Astato XS-20, 0.014″ X 300 cm, Asahi-Intecc) through a PiggyBack wire converter is then introduced to the tip of the traversal guide catheter, with its external end clamped to an electrosurgery pencil using hemostatic forceps after a 1 cm insulating coating of the wire is denuded with a scalpel. The traversal guiding catheter is then positioned in the mid base of the leaflet usually under fluoroscopic and TEE guidance. Radiofrequency energy is then applied for <1s in pure cut mode (50W) and the guidewire is advanced gently for 2-5 mm through the leaflet pointing to the LVOT. Once a leaflet is traversed, it is further advanced without the application of energy. The guidewire is then snared and held in place. Once the snare grasp is confirmed, the Piggyback wire converter is withdrawn outside the body. A flying 'V' is created outside as described before. The Piggyback wire converter is advanced close to the Flying 'V' and locked in position. The flying 'V' is then simultaneously advanced through the guide catheter and its hemostatic valve from one end, and the snare is pulled out from the other guide catheter until the flying 'V' straddles the leaflet sides for laceration.

Once the Flying 'V' is apposed to the leaflet and guide catheter tips placed close to it, the relative position of the guide catheter with respect to the wire is locked using a compatible torquer or mosquito clamps placed close to the hemostatic valves of the guide catheter. A pigtail catheter is also inserted through the TAVR access sheath into the LV so that rapid deployment of the TAVR valve can be performed in the event of severe regurgitation or hemodynamic instability after laceration. Then, the guidewire is electrified using 70W energy in 'pure cut' mode and tensed with simultaneous infusion of 5% dextrose solution using 2 large syringes. Once the leaflet is lacerated, the guiding catheters are removed one by one after releasing the lock and Astato guidewire from the catheter. TAVR valve placement then proceeds in the usual fashion after placing a TAVR guidewire through the previously placed pigtail catheter in the LV. If dual (left and right coronary leaflet) BASILICA is planned, the steps up to the advancement of the flying V to the leaflet are performed for each of the leaflets. The lacerations are then performed one by one. This is to avoid delays between the laceration of the leaflet and the valve deployment, as a long delay may risk hemodynamic deterioration.[10,14]

Outcomes Data

The BASILICA Investigational Device Exemption (IDE) trial was the pioneering study assessing the safety and feasibility of the BASILICA procedure.[15] This trial involved 30 patients diagnosed with severe bioprosthetic or native aortic valve disease, all with high/extreme risks for surgery and high risk for coronary artery obstruction. The results were encouraging, showing a 95% success rate in leaflet traversal and laceration and a complete absence of coronary obstruction and reintervention at 30 days. However, there was one mortality and 3 strokes, totaling a 10% rate within this duration.[16] When observed at 1 year, there were no additional strokes or myocardial infarctions, but 2 more fatalities were recorded, bringing the overall mortality rate to 10% for the first year.[16]

Building on the BASILICA IDE trial, the multicenter International BASILICA registry included 214 patients from 25 different centers across North America and Europe. The outcomes were in harmony with the earlier trial, showcasing a 94% success rate for leaflet traversal and laceration and an 87% success rate for achieving the BASILICA procedure without subsequent coronary obstruction, death, or reintervention.[17] In 5% of patients, some level of coronary obstruction was noted even post-BASILICA procedure. At the 30-day point, the mortality and stroke rate each stood at 3%, and the survival rate after 1 year was documented at 84%. To conclusively determine the safety and effectiveness of the BASILICA procedure, more expansive studies are imperative, preferably those that compare BASILICA to the snorkel stenting technique.

Pitfalls

BASILICA does not completely eliminate the risk of coronary obstruction, as 5% of patients in the BASILICA registry still experienced this coronary obstruction after the procedure. In selected cases, it may be reasonable to consider coronary protection using a guidewire and stent, in addition to BASILICA. BASILICA may help facilitate orthotopic stent placement rather than limiting options to a chimney-snorkel technique, potentially preserving future coronary access and possibly reducing the risk for stent thrombosis.[18] Another potential pitfall of the BASILICA procedure is related to the position of the stent post of the prior bioprosthetic valve or transcatheter valve. If these are situated directly in front of the coronary ostium, or if the coronary ostia is eccentrically located away from the midline of the leaflet, BASILICA may not be able to prevent obstruction.[19] In addition, aligning the TAVR valve commissural post away from the site of laceration is essential to prevent continued coronary obstruction post-TAVR. However, the absence of commissural alignment markers in many prevalent valves can complicate successful post-TAVR outcomes, rendering them contingent on factors not manageable by the operator.

LAMPOON

LVOT obstruction in transcatheter mitral valve replacement (TMVR) is noted in 10% to 40% of valve in MAC, 5% of valve-in-ring, and 0.7% to 2% of valve-in-valve cases and carries a high in hospital mortality of 62%.[20] Fixed obstruction can be predicted by a CT-neo LVOT area $<$170-190 mm^2 after TMVR, suggesting a higher risk for LVOT obstruction. Dynamic obstruction is difficult to predict, but acute aortomitral angle, prominent septal bulge, long anterior mitral leaflet, and redundant mitral chordae, increase the risk for LVOT obstruction.[20] Laceration of the Anterior Mitral leaflet to Prevent Outflow ObstructioN (LAMPOON) is a technique that mimics the surgical technique of anterior mitral leaflet resection to prevent LVOT obstruction.

Principle and Procedure

The anterior leaflet is lacerated along the longitudinal axis using transcatheter electrosurgery and the split leaflet parts away after the placement of the transcatheter heart valve (Sapien S3) maintaining the flow of blood through the open cells of the transcatheter valve. There are various iterations of the LAMPOON procedure.[20]

The classic/retrograde LAMPOON involves leaflet laceration from the retrograde or aortic approach.[21] Two 6Fr JL3.5 guide catheters are used, with one positioned in the LVOT abutting the base of the A2 leaflet. Similar to the technique described in BASILICA, the traversal guidewire (Astato XS 20, Asahi) is advanced inside an insulating Piggyback wire convertor and using 'pure' cutting mode at 50W is penetrated across the base of A2 scallop. The wire is snared in the left atrium, after which a Flying 'V' is created outside after the removal of Piggyback wire convertor. The guidewire is externalized, thereby advancing the Flying 'V'. It is then positioned across the mitral A2 leaflet. Then, the guidewire is electrified using 70W energy in pure cut mode and tensed with simultaneous infusion of 5% dextrose solution using 2 large syringes lacerating the leaflet. The further steps of TMVR proceed as usual.

Antegrade LAMPOON is less technically challenging and laceration is performed from a transseptal approach. This avoids the need for the 2 additional arterial accesses. In this approach, after the transseptal puncture obtained for TMVR (usually 3.5 cm from the mitral annular plane) 2 steerable guide catheters are inserted into the left atrium. A JR4 guide catheter is inserted through one of the Agilis sheaths and positioned at the base of the A2 scallop (traversal guide catheter) under TEE guidance and a JL 3.5 guide catheter is advanced through the other and positioned across the mitral valve in the LVOT with a snare. After guidewire traversal, the anterior mitral leaflet is lacerated in a fashion similar to the retrograde LAMPOON technique (Fig. 4).[22] Other iterations such as tip-to-base LAMPOON can be performed when the aortomitral curtain is shielded by a bioprosthetic mitral valve sewing ring. In this technique, laceration is performed with one end of 'Flying V' toward the LVOT and the other toward the mitral valve orifice. This avoids the need for leaflet traversal. In a similar fashion 'Rescue' LAMPOON can be performed as a last resort in cases where systolic anterior motion due to protruding anterior mitral leaflet causes LVOT obstruction post-TMVR.[23]

Outcomes Data

In a prospective, single arm multicenter study, LAMPOON IDE trial, 30 patients with severe mitral stenosis or regurgitation requiring TMVR, with extreme or high risk for surgical mitral valve replacements and high predicted risk for LVOT obstruction based on a neo-LVOT area of $<$200 mm^2 or long redundant anterior mitral leaflet underwent the 'Retrograde LAMPOON' procedure to mitigate the risk of LVOT obstruction post-TMVR.[24] Patients with a 'skirt neo-LVOT' $<$150mm2 were excluded from the study after observing LVOT obstruction even after laceration attributed to covered fabric skirt at the base of the Sapien 3 valve. There was 100% leaflet traversal and laceration and 100% survival immediately after the procedure and 93% survival at discharge and 30 days (100% for valve in ring, 87% for valve in MAC). Freedom from emergency surgery or reintervention related to LAMPOON or TMVR was 73%. 4 patients received concomitant alcohol septal ablation to decrease LVOT gradient. LVOT gradient was $<$30 mm Hg at the end of the procedure in 97% of patients. Of note, more than mild PVL was present in 23% of the patients and hypotension requiring an increase in vasopressors or mechanical support was present in 40% of the patients.[24]

Lisko and colleagues, reported the outcomes of a retrospective series of 21 patients undergoing tip-to-base LAMPOON(23). The main findings were that the procedure was 100% feasible and effective in preventing LVOT obstruction with a 100% survival rate of 30 days. However, 2 patients suffered an iatrogenic aortic valve injury leading to severe aortic regurgitation and needed aortic valve replacements.

Pitfalls

Technical complexity of the Retrograde LAMPOON procedure was a limitation and is much improved with Antegrade LAMPOON technique.[22] LAMPOON procedure is not effective in patients with a skirt neo-LVOT$<$150 mm^2

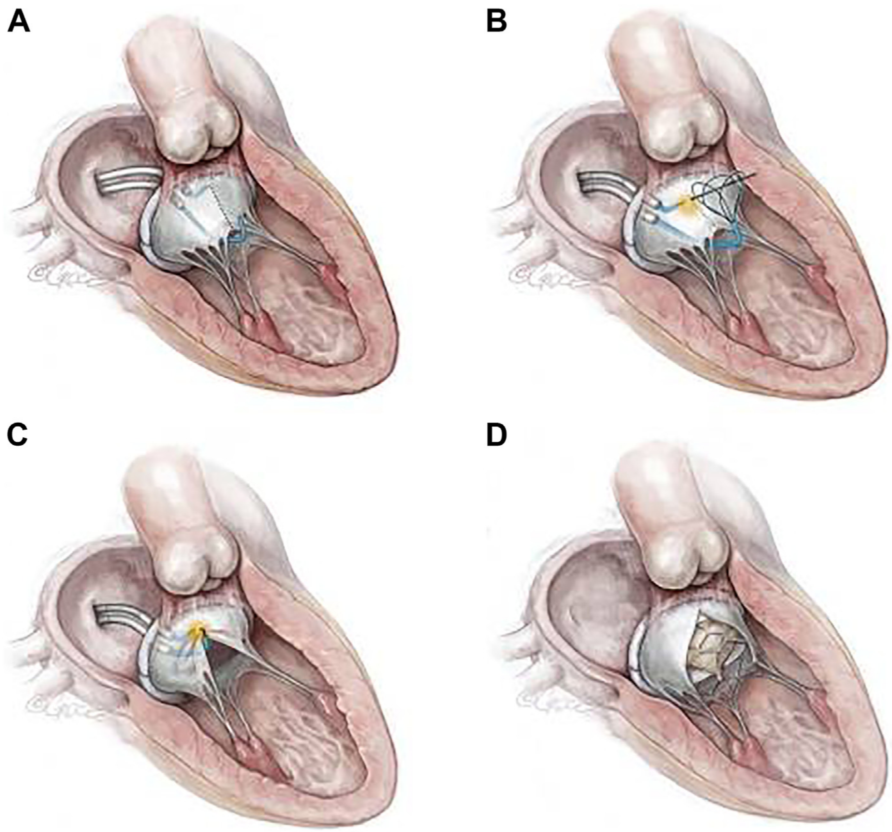

Fig. 4. Antegrade LAMPOON procedure. (*A*) Two defectable sheaths with guide catheters are advanced to the left atrium after transseptal puncture. One guide catheter is positioned at the midline-base of the anterior mitral leaflet under transesophageal echocardiogram guidance and other in the left ventricular outflow tract (LVOT). (*B*) LVOT snare is placed and an energized Astato guidewire is advanced through the anterior mitral leaflet to the LVOT (*C*) Astato guidewire is snared and externalized to position the "Flying V", aligned with A2. Tension is applied with electrosurgery while infusing 5% dextrose to lacerate the anterior mitral leaflet along its centerline. (*D*) Transcatheter mitral valve replacement (TMVR) performed in the standard fashion, allowing leaflet halves to separate from the LVOT. (Brian C. Case et al., LAMPOON techniques to prevent or manage left ventricular outflow tract obstruction in transcatheter mitral valve replacement, Annals of Cardiothoracic Surgery, 10 (1), 2021, https://www.annalscts.com/article/view/16797.)

as the fabric skirt of the THV will continue to cause LVOT obstruction even after leaflet laceration and such patients were excluded from the LAMPOON IDE trial once this phenomenon was recognized. Emergency surgery or reintervention related to LAMPOON or TMVR was needed in 27% of patients and more than mild PVL was present in 23% of the patients undergoing the LAMPOON technique prior to TMVR in the LAMPOON IDE trial.[24]

ELASTIC AND ELASTA-CLIP

TMVR in patients with prior mitral valve repair with Alfieri stitch or transcatheter edge to edge repair (TEER) can be associated with increased risk for transcatheter valve malapposition, maldeployment, or underexpansion. Therefore, it is desirable to create a single orifice for predictable valve deployment. This can be achieved by Electrosurgical Laceration of Alfieri StItCh (ELASTIC) or Electrosurgical Laceratrion and Stabilization of failed MitraClip (ELASTA-Clip).[25,26]

Principle and Procedure

Utilizing electrosurgery to lacerate an Alfieri stitch or a mitral clip will result in a singular, central mitral orifice. The procedure can be performed from retrograde (as initially described) or antegrade approach with the latter typically being less complex technically. In antegrade ELASTIC, 2 steerable Agilis sheaths are placed in the left atrium after transeptal puncture,[27] through which 2 JR4 guide catheters are placed into each medial and lateral orifice. Afterward an Astato guidewire is passed through one guide catheter and snared by the other in the left ventricle. Like BASILICA/LAMPOON techniques, a flying V is the created and advanced to the level of Alfieri stitch after which it is lacerated by electrosurgery. Subsequently, TMVR is performed in the standard fashion. In ELASTA-Clip, the anterior mitral leaflet is lacerated and the THV will secure the posterior leaflet and retained mitraclip between the myocardium and the new valve at the end of the procedure.[26]

Outcomes Data

Only small case series and case reports are available that demonstrate the success of this technique. Lisko and colleagues described a series of 5 consecutive patients undergoing ELASTA-Clip procedure prior to Tendyne transcatheter mitral valve implantation and reported no deaths, valve dysfunction, or reintervention at 30 days.[26] Khan and colleagues previously reported a case of retrograde ELASTIC, and our team has previously reported a case of successful antegrade ELASTIC procedure prior to TMVR.[25,27]

Pitfalls

In our opinion, the antegrade ELASTIC procedure is replicable and achievable for operators with some experience in electrosurgical laceration procedures (Fig. 5). However, large sample sizes of data on patient safety and efficacy are currently not available.

SESAME

SEptal Scoring Along Midline Endocardium (SESAME) is a technique developed to mimic surgical myectomy in patients requiring left ventricular septal reduction.[28] Alcohol septal ablation to relieve LVOT obstruction is often fraught with inadequate debulking, complete heart block requiring a pacemaker, geographic miss, and the need for time dependent myocardial necrosis. The SESAME procedure may offer septal debulking in patients at risk for LVOT obstruction post TMVR, with hypertrophic cardiomyopathy, and for those who are poor candidates or have failed alcohol septal ablation.[29]

Principle and Procedure

SESAME procedure is based on the principle that a single laceration of the myocardium through its partial thickness will splay open the

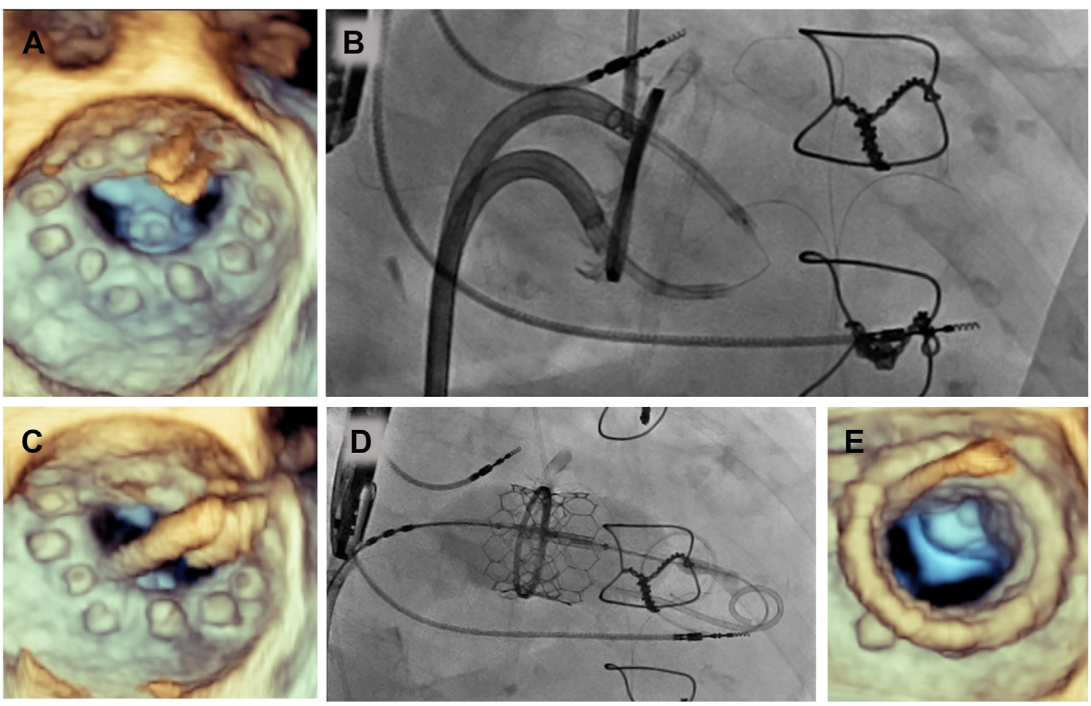

Fig. 5. Antegrade ELASTIC procedure (*A*) 3D-transesophageal image of the mitral annuloplasty ring with Alfieri Stitch (*B*) Fluoroscopic image depicting guide catheters in each medial and lateral mitral valve orifice with “flying V” of Astato guide wire (ASAHI INTECC) positioned at the Alfieri Stitch (*C*) Mitral valve immediately after laceration (*D* and *E*) Deployment of Transcatheter heart valve in the single central mitral orifice.

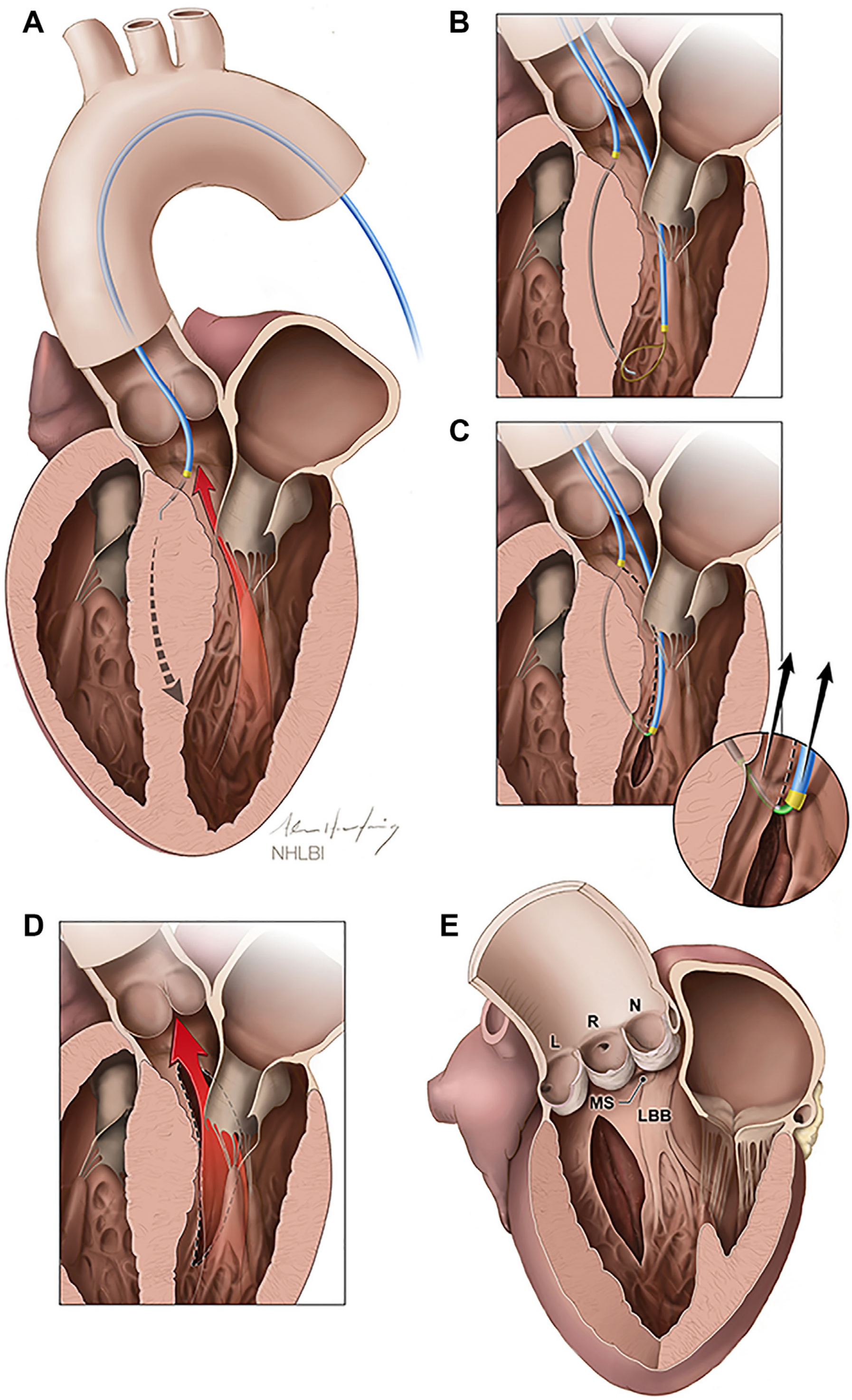

Fig. 6. SESAME (Septal Scoring Along the Midline Endocardium) procedure. (*A*) An Astato guidewire featuring a chronic total occlusion tip is maneuvered through the interventricular septum. (*B*) With the support of a microcatheter, the guidewire traverses through the myocardium and re-enters the left ventricular cavity after which it is snared with a prepositioned snare. (*C*) Guidewire externalized and 'Flying V' advanced to the LV, and electrified with application of traction to produce myotomy. (*D*) Post-transcatheter SESAME procedure, the muscle fibers splays open, creating more room in the left ventricular outflow tract and facilitating improved blood flow. (*E*)

muscle layers due to the laceration of the horizontal fibers. This laceration when performed at the site of hypertrophied LVOT should cause immediate improvement in the LVOT area and thereby decrease obstruction (Fig. 6).

The procedure is planned on multiphase computed tomography, to obtain optimal orthogonal fluoroscopy projections (side view of the septum for depth and cranial view for medial-lateral) and an optimal laceration trajectory. After obtaining 2 small bores of arterial access, a 6Fr guide catheter such as a hockey stick, is advanced into the LVOT and pointed and engaged in the direction of the basal myocardium between the left-right aortic cusp commissures (away from conduction tissue) and below the level of right coronary sinus. A tip amputated guidewire or a straight tip guidewire (AstatoXS20; Asahi) is used to enter the myocardium after which a microcatheter (such as Caravel) is advanced slightly into the myocardium. The guidewire is then exchanged for a CTO tip guidewire (Astato XS20) and advanced through the desired trajectory after which it is reentered into the LV cavity. The guidewire is then snared in the LV cavity with a second guide catheter. Similar to other electrosurgical laceration techniques, a flying 'V' is then created after the microcatheter is removed and the flying 'V' is advanced into the LV. Laceration is then performed with 70W electrosurgery by tensing the guide catheters.[28,29]

Outcomes Data

SESAME procedure is a recently developed procedure and therefore outcomes data involving multiple patients are not available, though animal studies are promising. Greenbaum and colleagues, had performed this procedure, a first in humans, with excellent results relieving the LVOT gradient without any major complications.[29]

Pitfalls

Potential complications of the procedure include iatrogenic ventricular septal defect, myocardial perforation, mitral chordal injury, conduction block, and aortic valve injury. Moreover, there is a lack of safety and effectiveness data for this procedure, and there is a steep learning curve.[29]

SUMMARY

Electrosurgery has brought transformative advancements to the realm of structural cardiac interventions, providing innovative solutions to challenges that once necessitated invasive open surgeries. The transcaval access, BASILICA, LAMPOON, ELASTIC/ELASTA-Clip, and SESAME procedures represent the cutting edge of electrosurgery applications, each tailored to address specific complexities in structural cardiac interventions. While these techniques have shown promising outcomes and ushered in a new era of minimally invasive procedures, ongoing research and advancements are essential to further enhance their safety, efficacy, and applicability. As technology continues to evolve and experience grows, electrosurgery stands poised to continue revolutionizing the landscape of cardiac care, offering new hope and improved outcomes for patients with complex structural heart conditions.

DISCLOSURE

V. Iyer reports a relationship with Boston Scientific Corp that includes consulting or advisory and with Edwards Lifesciences Corporation that includes speaking and lecture fees. All other authors report no conflicts of interest.

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The SESAME incision strategically avoids interaction with the conduction system. In this illustration, "L" signifies the left cusp; "LBB" refers to the left bundle branch; "MS" represents the membranous septum; "N" denotes the noncoronary cusp, and "R" symbolizes the right cusp. (Khan, J. M. et al., (2022). Transcatheter myotomy to relieve left ventricular outflow tract obstruction: the septal scoring along the midline endocardium procedure in animals. Circulation: Cardiovascular Interventions, 15(6). https://doi.org/10.1161/circinterventions.121.011686.)

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