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Radiofrequency ablation of deep seated outflow tract ventricular tachycardia using custom modified bipolar irrigated radiofrequency ablation setup

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A R T I C L E I N F O

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1. Introduction

Trans-catheter radio frequency ablation (RFA) of outflow tract ventricular tachycardia (OTT) has a decent success rate of up to 82%. But the recurrences are possible in half of patients on long term follow-up [1]. Improvement in mapping and RFA technologies try to increase both acute and long-term success rates [2]. RFA catheter with the capacity to show real time tip to tissue contact force has been reported recently in outflow tract tachycardia to create a transmural lesion [3]. Deep seated intramural arrhythmic sources often not reachable by the standard RFA catheters. Failure to ablate such focus even by the irrigated RFA catheters is not uncommon. Bipolar RFA (B-RFA) is necessary in such scenarios. But it is not widely used because of the non-availability of the equipment in all cardiac electrophysiology laboratories (EP-lab). We describe the feasibility of B-RFA in a standard EP-lab by simple modification of the existing RFA circuit.

2. Case report

A 38 year old lady with the history of recurrent episodes of drug refractory palpitation and presyncope was referred for RFA. The echocardiogram revealed tachycardiomyopathy with the left ventricular ejection fraction of 46%. At baseline, electrocardiogram showed ventricular trigeminy (Fig. 1A). The focus of origin was suspected from the right ventricular outflow tract (RVOT), as the morphology was left bundle branch block (LBBB) with an axis of +110°. Transition was noted in V4 and the QRS in Lead I was positive which suggested the RVOT postero-septal region as the exit point (Fig. 1B). With the decapolar catheter in coronary sinus (CS), roving catheter (4mm open irrigated RFA catheter) was used for activation mapping of the RVOT using impedance based 3 dimensional electro anatomic mapping system (3D-EAMS, NavX, Precision Ensite, Abbott, Santa Clara, CA). 3D-EAMS showed the RVOT postero-septal region as the earliest point (Fig. 2A), 28 ms ahead of the surface QRS (Fig. 2B). Pace mapping from the same point showed 12/12 match. Hence radiofrequency energy (RF) was delivered with 35 watt power at 43 °C temperature, for 120 seconds using open irrigated RFA catheter (Flexability™, Abbott, Santa Clara, CA). The premature ventricular complexes (PVC) disappeared after 45 seconds of ablation and reappeared within 3 minutes. Few more RF energies were delivered at the same settings. Since the PVC persisted and a wide area of early signals were obtained in the RVOT septum it was decided to map the adjoining areas namely left ventricular outflow tract (LVOT), anterior mitral commissure (AMC), anterior interventricular vein (AIV) and the overlying epicardium. LVOT was mapped retrogradely with the same catheter. While mapping, the roving catheter was accidentally entered left main coronary artery (LMCA) and the moment was used to create the geometry of LMCA. The earliest electrogram (EGM) was found to arise in the left coronary cusp (LCC, Fig. 2C), 30 ms ahead of surface QRS (Fig. 2D). Few RF energies were delivered at this site after ensuring that it was safely away from the LMCA by angiogram and the LMCA geometry in 3D-EAMS. During ablation acceleration of the PVC followed by termination was noted. Unfortunately recurrence was noted in a few minutes. AMC region was late during activation mapping and AIV could not be entered as it was small. Maximum deflection index (MDI) was 0.68 which suggested either

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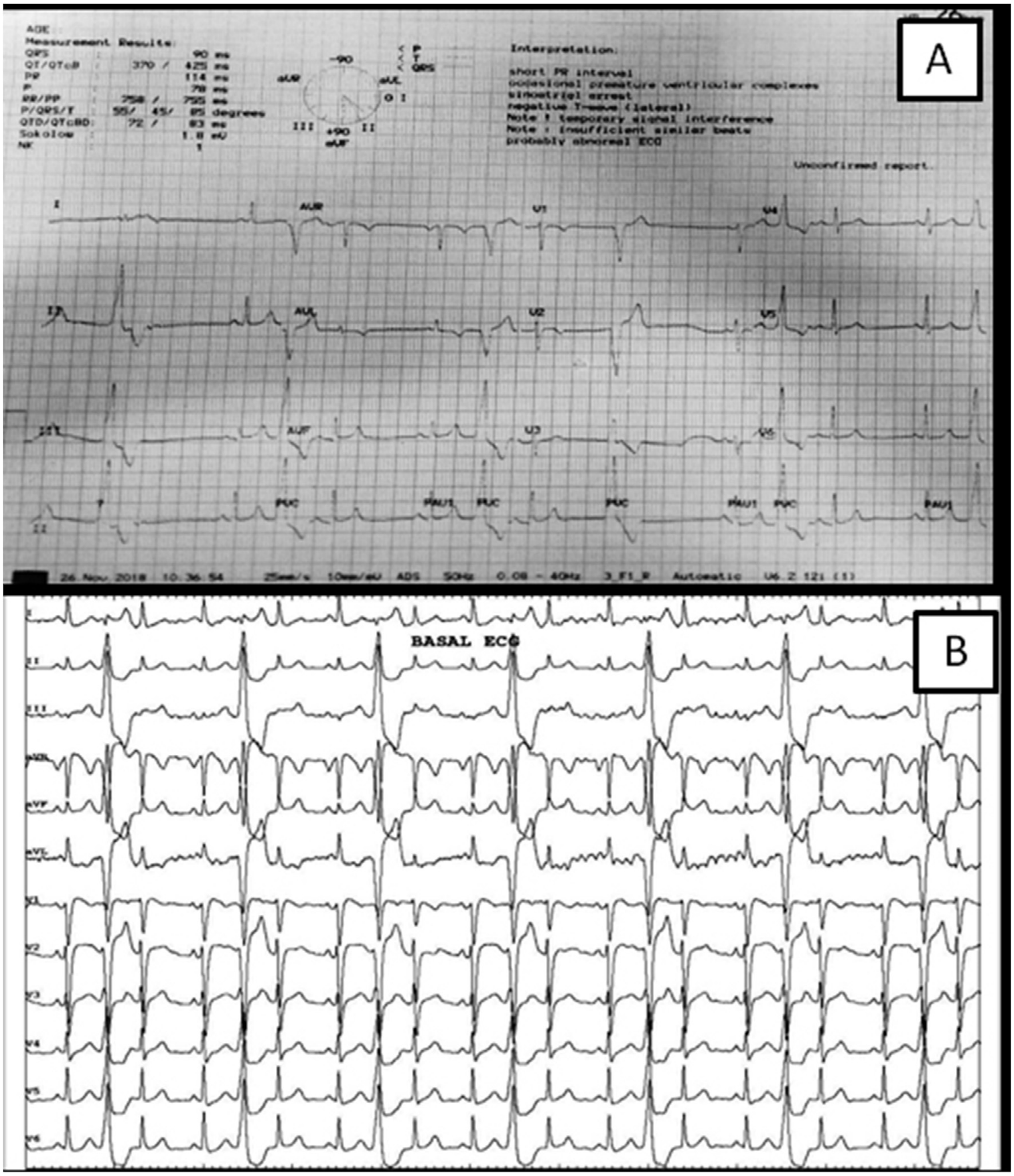

Fig. 1. A) 12 lead surface electrocardiogram (ECG) with lead II rhythm strip at 25mm/sec with 10mm/mv standardization shows ventricular trigeminy, left bundle branch morphology with an axis of +110°. During premature ventricular contraction (PVC) Lead 1 showed positive QRS and the transition was noted in V4 that suggested right ventricular outflow tract (RVOT) postero-septum as the exit point. B) 12 lead basal ECG during electrophysiology study showed similar findings as mentioned above.

deep seated focus in the outflow tract septum or the PVC was arising from an epicardial origin. Hence a B-RFA of outflow tract septum was considered before epicardial mapping through pericardial sheath. As the EP-Lab did not have the B-RFA hardware it was decided to use custom made setup as described below.

3. Bipolar RFA setup

An open irrigated RFA catheter (Therapy™ Cool flex™, Abbott, Santa Clara, CA) was placed in LCC and an another open irrigated RFA catheter (Flexability™, Abbott, Santa Clara, CA) was placed in RVOT at the corresponding earliest points. LCC catheter was irrigated using the standard circuit and RVOT catheter was irrigated using 50 ml syringe manually (Fig. 3A). LVOT catheter was connected to the anodal end of ablator via an 85641 ablation cable (Figure-3B) and the cathode port of ablator was connected to the jumper cable via a custom made cable for grounding (Fig. 3C). Jumper cable was connected to the junction box (Fig. 3D). The other end of the jumper cable was connected to the RVOT catheter through an Inquiry decapolar cable and the circuit was completed (Fig. 3E). First the bipolar RF energies were delivered using RVOT end as active ablation point and the LCC end as the ground (Fig. 4A). This was not successful. When the B-RFA was done using LCC end as active ablation point and RVOT end as grounding (Fig. 4BB,C), using

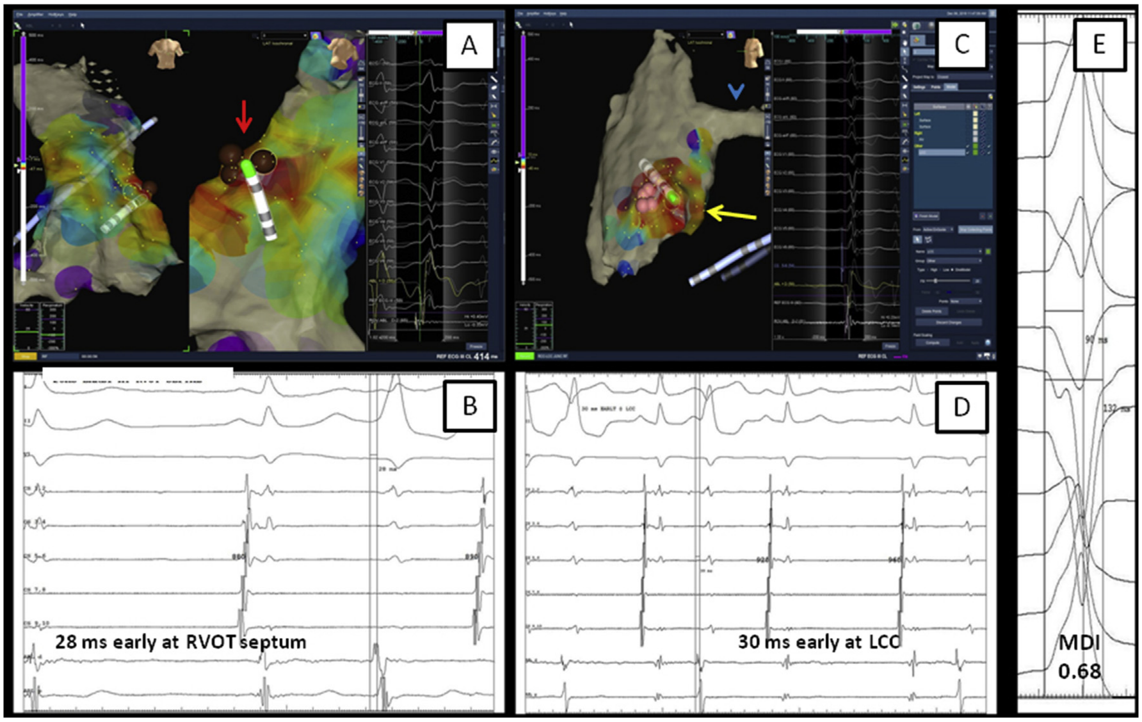

Fig. 2. A) 3D electro anatomic activation map (during PVC) of RVOT in antero-posterior view and left posterior oblique view showed earliest site at the postero-septum (red arrow). B) Intra cardiac electrogram showed the signals from the ablation catheter (lower 2 channels) at right ventricular postero-septal outflow tract (corresponding position in 3D map is showed in Fig. 2A) is 28 ms earlier than surface QRS. C) 3D electro anatomic activation map (3D-EAM) during PVC of left ventricular outflow tract in left anterior oblique showed earliest site at left coronary cusp (LCC, yellow arrow). Accidental entry of roving catheter into the left main coronary artery (LMCA) was used to create the geometry of the same (blue arrow head). D) Intra cardiac electrogram showed the signals from the ablation catheter (lower 2 channels) at LCC (corresponding position in 3D map is showed in Fig. 2C) is 30 ms earlier than surface QRS. E) Maximum deflection index of PVC was 0.68.

20 watt power at 43 °C, RVOT ventricular tachycardia was initiated (Fig. 4D) immediately and terminated (Fig. 4E). A vigorous induction protocol was used post RFA to check the recurrence but PVC did not recur. At three months of follow-up, LVEF was normalized and neither 24 hour Holter nor exercise ECG revealed any PVC.

4. Discussion

Unipolar configuration is used in standard RFA, between the ablation catheter tip and a ground patch placed on the body surface of the patient. OTT is usually ablated using unipolar radio frequency ablation (U-RFA) with a good success and less recurrence. Poor contact of the ablation catheter with the tissue, incomplete mapping and deep seated focus in the outflow tract septum are generally considered as the reasons for recurrence. Recently contact force catheter has been used to overcome the contact issue as the reason for failure [3]. The deep seated focuses are generally been dealt with irrigated cooled ablation catheter in order to enhance the energy delivery into the deep tissue. Steam pop is a problem during ablation of the deep seated focuses that require higher energy. RFA from both side of the outflow septum can be the option either by sequential unipolar radio frequency ablation (SeU-RFA) or by simultaneous unipolar radio frequency ablation (SiU-RFA). SiU-RFA requires two ablators. González-Suárez A et al. demonstrated the distributions and lesion dimensions created by SeU-RFA, SIU-RFA and B-RFA on interventricular septum (IVS) and ventricular free wall (VFW) with the use of computational models. SeU-RFA and SiU-RFA were not able to create transmural lesions with IVS thickness ≥12.5 and 15mm respectively. B-RFA created symmetrical and transmural lesions for thickness up to 15mm. They concluded that B-RFA was superior to both types of unipolar modes [4]. The transmural lesion in a thicker tissue is easily produced by B-RFA rather than sequential U-RFA on both sides [5]. Previous reports showed that U-RFA lesions can be 7 mm deep and B-RFA lesions can be 15 mm deep. Retrospectively we measured the distance between the RVOT and LVOT ablation catheters as 18mm by applying field scaling and tape measurement in NavX system (Fig. 5). The SeU-RFA might not ablate the 4 mm center of deep myocardium (7mm from both sides {7 + 7 = 14}; 18-14 = 4). The lesion depth in B-RFA depends on parallel or perpendicular position of the active and grounding catheter, intercatheter distance and 4mm or 8mm irrigated vs. non-irrigated catheter tips. In this report we used 4mm irrigated ablation catheter tip as active and grounding and these were placed parallel to each other with a distance of 18mm [6]. The thermal latency of SeU-RFA vs. B-RFA was the reason of success in our report is a debate. Though the thermal latency had been proposed as the hypothesis in vivo, there were no clear cut recommendations about how long to wait during the procedure in order to call it as successful vs. unsuccessful. The configuration of U-RFA circuit was custom modified into B-RFA circuit, such that instead of the ground patch, a second ablation catheter was designated as the grounding connection for the active RFA catheter. But the connection required a distal port of a decapolar cable and a jumper cable in the present case. This report demonstrates the feasibility of B-RFA across outflow tract septum in a resistant scenario using easily available decapolar and jumper cables. As the NavX mapping system is impedance based open system, both the active and grounding RFA catheters as well as associated EGMs can be visualized simultaneously. Generally in NAVX system we can visualize only one ablation catheter. By using

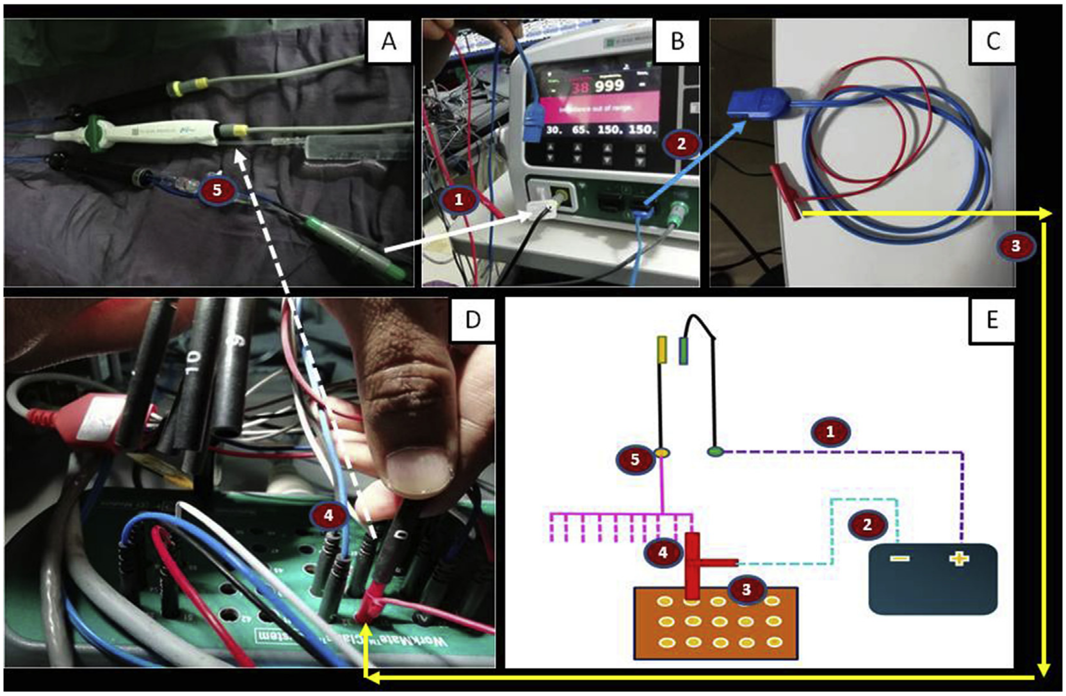

Fig. 3. A) 3D electro anatomic map (3D-EAM) during bipolar ablation in left anterior oblique view and left lateral view showing right ventricular outflow (RVOT) catheter in white colour with green tip (active) and left coronary cusp (LCC) catheter (grounding) in yellow colour. B) 3D-EAM during bipolar ablation with polarity swap in left anterior oblique view and left lateral view showed LCC catheter in white colour with green tip (active) and RVOT (grounding) in yellow colour. C) Fluoroscopic image in left anterior oblique view showed retrograde ablation catheter in LCC and antegrade catheter in RVOT during bipolar ablation. The decapolar catheter in coronary sinus and 5F TIG diagnostic catheter (radial access) that was used to confirm that left main coronary artery was safely away from the ablation site, was parked in ascending aorta are also seen. D) 12 lead surface ECG showed initiation of ventricular tachycardia immediately after the onset of bipolar ablation with LCC as the active end and RVOT as the grounding. E) 12 lead surface ECG showed successful termination of PVCs during bipolar ablation.

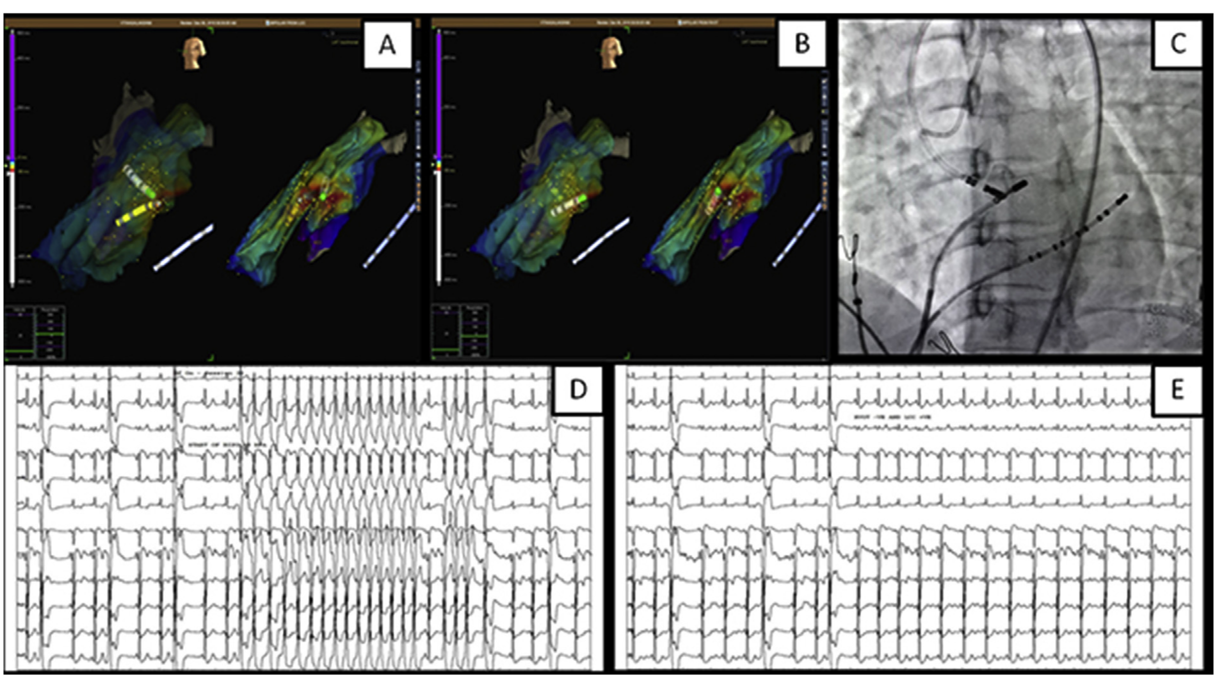

Fig. 4. A) From above to below coronary sinus decapolar catheter with black handle, Flexability™ open irrigated ablation catheter attached with a 50 ml syringe with white handle and Therapy™ Cool flex™ ablation catheter attached to the standard irrigation line of the ablator system with black handle. B) Standard radiofrequency ablator, C) Red colour jumper cable with a custom blue cable, D) Junction box with attached red colour jumper cable. One end of the jumper cable is attached to the ablator and another end to the decapolar cable. E) Pictorial representation of the bipolar ablation circuit. (1) Therapy™ Cool flex™ ablation catheter from left coronary cusp is connected to the anodal port of the ablator through an 85641 ablation cable (white arrow from figure A to B). (2) A custom cable was attached from the cathode port of the ablator to T-cable (blue arrow from figure B to C). (3) T-cable was attached to the junction box (yellow arrows connecting figure C to D). (4) Another end of the jumper cable was attached to an Inquiry decapolar cable (white arrow from figure D to A). (5) Inquiry decapolar cable is attached to the Flexability™ ablation catheter from right ventricular outflow tract.

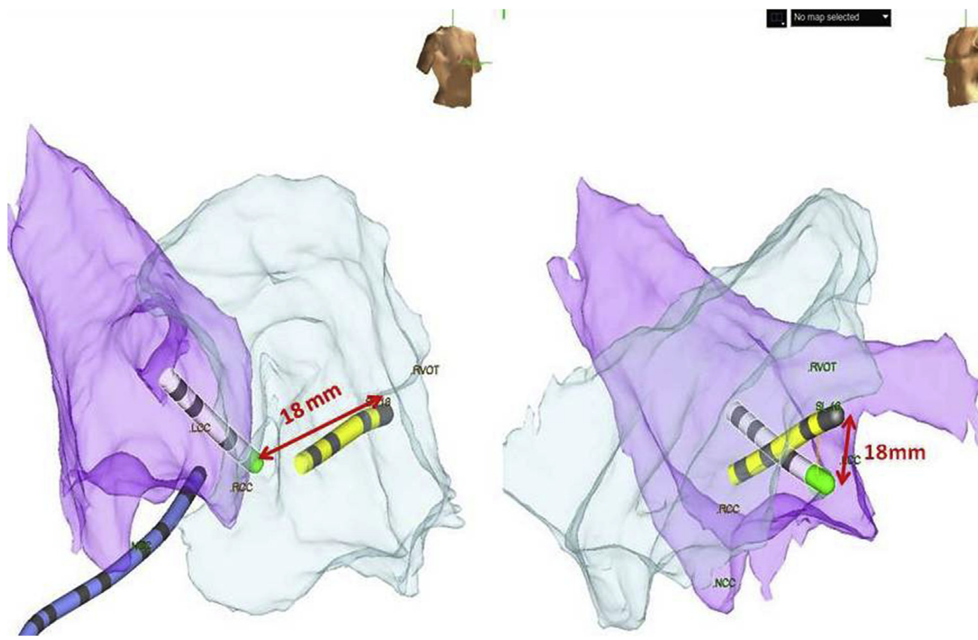

Fig. 5. Right anterior oblique and left anterior oblique views of the 3 dimensional electro anatomical mapping system shows both right ventricular outflow tract (RVOT) and left ventricular outflow tract (LVOT). The distance between the RVOT and LVOT ablation catheters were measured as 18mm using NavX field scaling and tape measurement as 18 mm. Sequential unipolar ablation might have given 7 mm deep lesions from both sides, hence the remaining 4 mm tissue in the centre might not get ablate.

our circuit not only simultaneous visualization but also measurement of EGM timing of both catheters and inter-changing the polarity is possible. Polarity changing of the active and grounding ablation catheters should be tried in case if first one fails. In our case success was achieved while switching the active ablation end as LCC and grounding end as RVOT. The mechanism of changing polarity in relation to the successful ablation was not elucidated yet. It is better to assign the LCC catheter to the active end, as temperature read off from LCC during RFA is safer. Despite limited reports [6,7], the safety, feasibility and outcome of B-RFA across the coronary cusp is an unexplored area and the potential area of research, as no strong evidence is available as of now. Sauer PJ et al. reported successful ablation of midmyocardial septal outflow tract VT using custom modified bipolar ablation setup. They used a T-cable that was used to refine recordings from an RFA catheter with an old RF generator and NavX system. The distal pin of the T-cable was connected to the jumper cable and which in turn connected to the grounding port [7]. We used the decapolar cable in place of the T-cable as we did not have the inventory. To our knowledge after the extensive literature search, this is the first case report of B-RFA in India. Currently an investigational device is under evaluation to assess safety and efficacy of B-RFA, in which not only simultaneous visualization of both the catheters but also intercatheter distances and active catheter force registration is possible (ClinicalTrials.gov; Clinical Study Identifier: NCT02374476).

5. Limitations

Surrogate points for contact and stability of the ablation catheter which is considered as grounding, is not possible. Off-label use of custom modified equipment requires specific informed consent from the patient. The risks of charring, steam pop and fistula formation were not studied yet. During B-RFA temperature and impedance data are only available from the active RFA catheter site; hence char formation or steam pop at the grounding catheter site could not be monitored. Intra cardiac echocardiography may be useful for monitoring the grounding catheter site [7].

6. Conclusion

In the scenario of deep seated outflow tract septal focus, where lesion depth is not enough even with the standard open irrigated RFA catheter, B-RFA may give success. The setup of B-RFA can be easily made from the standard inventory in any one of the EP-lab in our country. Not to forget that a large randomized study is required to prove the safety, feasibility and outcome of B-RFA.

Declaration of interest

None.

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References

[1] Ventura R, Steven D, Klemm HU, et al. Decennial follow-up in patients with recurrent tachycardia originating from the right ventricular outflow tract: electrophysiologic characteristics and response to treatment. Eur Heart J 2007;28:2338–45.
[2] Thornton AS, Jordaens LJ. Remote magnetic navigation for mapping and ablating right ventricular outflow tract tachycardia. Heart Rhythm 2006;3:691–6.
[3] Valk SDA, De Groot NMS, Jordaens L. Catheter ablation of right ventricular outflow tract tachycardia using contact force guidance. Neth Heart J 2014;22:460–2.
[4] González-Suárez A, Trujillo M, Koruth J, et al. Radiofrequency cardiac ablation with catheters placed on opposing sides of the ventricular wall: computer modelling comparing bipolar and unipolar modes. Int J Hyperth 2014;30:372–84.
[5] Koruth JS, Dukkipati S, Miller MA, et al. Bipolar irrigated radiofrequency ablation: a therapeutic option for refractory intramural atrial and ventricular tachycardia circuits. Heart Rhythm 2012;9:1932–41.
[6] Nguyen DT, Tzou WS, Brunnquell M, et al. Clinical and biophysical evaluation of variable bipolar configurations during radiofrequency ablation for treatment of ventricular arrhythmias. Heart Rhythm 2016;13:2161–71.
[7] Sauer PJ, Kunkel MJ, Nguyen DT, et al. Successful ablation of ventricular tachycardia arising from a midmyocardial septal outflow tract utilizing a simplified bipolar ablation setup. Heart Rhythm case rep 2019;5:105–8.