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

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Introduction: Trans-catheter radio frequency ablation (RFA) of outflow tract ventricular tachycardia has a decent success rate of upto 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 foci even by the irrigated RFA catheters is not uncommon. Bipolar RFA (bRFA) 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).4 We describe the feasibility of bRFA in a standard EP-lab by simple modification of the existing RFA circuit.

Methods: A 38 year old lady with the history of recurrent episodes of drug refractory palpitations and presyncopal episodes was referred for RFA. The echocardiogram revealed tachycardiomyopathy with the left ventricular ejection fraction of 46%. At baseline, electrocardiogram showed ventricular trigeminy. The focus of origin was suspected from right ventricular outflow tract (RVOT) as the morphology was 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. With the decapolar catheter in coronary sinus (CS), rowing catheter (4mm open irrigated RFA catheter) was used for mapping the RVOT was mapped using impedance based 3 dimensional electro anatomical mapping system (3D-EAMS). 3D-EAMS showed the RVOT postero-septal region as the earliest point, 28 ms ahead of the surface QRS. Pace mapping from the same point showed 12/12 match. Hence radiofrequency energy (RF) was delivered with temperature, power for seconds. The premature ventricular complexes (PVC) disappear after seconds of ablation. Within 3 minutes PVC started to reappear. more episodes of RF energies were delivered at the same settings. As the PVC once again reappeared left ventricular outflow tract was mapped retrogradely with the same open irrigated rowing catheter. During 3D mapping rowing catheter was accidentally entered left main coronary artery (LMCA) and the moment was used for mapping the LMCA. The earliest point was found to arise from left coronary cusp (LCC), 30 ms ahead of surface QRS. Few RF energies were delivered at the earliest point after the confirmation of safe distance of LMCA location from the RFA site by angiogram. During ablation PVC were accelerated and terminated, yet recurrence happened in few minutes. Hence a try to search for other areas like anterior mitral commissure (which was late) was done but failed to identify the earliest region. Maximum deflection index (MDI) was measured to rule out the epicardial origin. As the MDI was 0.68, left ventricular summit was tried for mapping through CS but failed because of small anterior interventricular vein. Epicardial mapping was in the plan through pericardial sheath. But one another reason for MDI > 0.55 was deep seated focus apart from epicardial site. Hence a bRFA of outflow tract was considered before epicardial mapping. As the EP-Lab did not have the bRFA hardware it was decided to use custom made setup as described below. Bipolar RFA setup Irrigated RFA catheter
(TherapyTM Cool flexTM, Abbott, Santa Clara, CA) catheter was placed in RVOT and another open irrigated RFA catheter (FlexibilityTM, Abbott, Santa Clara, CA) was placed in LCC at the corresponding earliest points. RVOT catheter was irrigated using the standard circuit and LVOT was irrigated using 50 ml syringe manually. LVOT catheter was connected to the anodal end of ablator via an 85641 ablation cable and the cathode port of ablator was connected to the jumper cable via a custom made cable for grounding. Jumper cable was connected to the junction box. The other end of the jumper cable was connected to the RVOT catheter through an Inquiry decapolar cable and the circuit was completed. First the bipolar RF energies were delivered using RVOT end as active ablation point and the LVOT end as the ground but not succeeded. When the bRFA was done using LVOT end as active ablation point and RVOT end as grounding using 20 watt power at 43 degree Celsius, RVOT ventricular tachycardia was accelerated immediately and terminated. Vigorous induction protocol was used post RFA to check the recurrence but PVC did not recur. At three months follow-up LVEF was normalized and neither 24 hour Holter nor exercise ECG reveals any PVC.

Result: Unipolar configuration is used in standard RFA, between the ablation catheter tip and a ground patch placed on the body surface of the patient. Outflow tract tachycardia is usually ablated using unipolar radio frequency ablation (uRFA) with a good success and less recurrence. Poor contact of the ablation catheter, incomplete mapping and deep seated foci in the outflow 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. The deep seated foci are generally 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 foci higher energy. RFA from both side of the outflow septum can be the option either alternately using single uRFA or double uRFA simultaneously, but the later requires two ablator. The configuration of uRFA circuit was custom modified into bRFA circuit, such that instead of the impedance patch, a second ablation catheter was designated as the grounding connection for the active RFA catheter. But the connection requires a distal port of a decapolar cable and a jumper cable. This report demonstrates the feasibility of bipolar ablation across outflow tract septum in a resistant scenario using easily available decapolar and jumper cables. As the mapping system & EnSite Precision, Abbott; is impedance based open system both the active and grounding RFA catheters can be visualized in the 3D-EAM as well as associated EGMs simultaneously. Usually the size and depth of the lesion on the active catheter side is bigger than the grounding catheter site. Hence changing the active and grounding vice versa should be tried in case if first one fails. In our case success was achieved while switching the active ablation end as LVOT and grounding end as RVOT. 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.4 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 bipolar ablation in India. Currently an investigational device is under evaluation to assess safety and efficacy of bRFA, in which not only the simultaneous visualization of both the catheters but also intercatheter distances and active catheter force registration is possible (ClinicalTrials.gov; Clinical Study Identifier: NCT02374476). 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 charing, steam pop and fistula formation were not studied yet. During bRFA 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.

Conclusion: Deep seated septal origin of foci, where energy delivery is not reaching even with the standard open irrigated RFA catheter, bRFA may give success. The setup of bRFA can be easily made from the standard inventory in any one of the EP lab in our country. Not to forget large randomized study is required to prove the safety, feasibility and outcome of bRFA.