Catheter mapping and ablation of unstable VTAs with percutaneous mechanical support systems

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Outline

• What is unstable VT?

• Do we need hemodynamic support devices?
  – Preclinical data
  – Case Example
  – Clinical Outcome
Why even consider hemodynamic support to convert unstable $\rightarrow$ stable VT?

- Clinically, we get away with induction/termination and targeted entrainment mapping:
  - Define the scar
  - Identify putative exit site: pace-mapping (QRS morphology & latency)
  - Induce and do a “quick” entrainment $\rightarrow$ terminate
  - Re-induce $\rightarrow$ Delivery RF energy to terminate (in < 10 secs)

- So what is the problem?
  - Repetitive induction can be frustrating (difficult, multiple morphologies)
  - Don’t know how long to stay in VT (ie, what is “unstable”)
“Hemodynamically-Unstable” VT

- Lacks a reliable/validated monitoring modality:
  - **Blood Pressure??**
    - Systolic or Diastolic or Mean pressure?
    - What is an acceptable level? <60…50…40??
  - **Pulmonary artery catheterization?**
    - No information on end-organ perfusion
  - **Arterial lactate levels?**
    - Not dynamic enough
  - **Urinary Output?**
    - Not dynamic enough
  - **Pulse oximetry?**
    - Delayed response

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Cerebral Oximetry:
The next step in VT hemodynamic monitoring?

• Cerebral perfusion is important indicator of systemic perfusion. In fact, the most sensitive indicator of end-organ perfusion is the brain, because it is exquisitely sensitive to hypoxia.¹

• Cardiac and neurosurgery studies utilizing cerebral oximetry monitoring demonstrate an association between cerebral desaturation events and adverse outcomes.
  – CABG trial (randomized): No adverse events in patients whose absolute value always remained >50%.²
  – CABG trial (randomized): monitoring of cerebral oximetry and intervening for cerebral desaturations associated with less major organ dysfunction post-operatively.³

• Baseline cerebral oxygen saturation (prior to and in between inductions) may correlate with LV dysfunction and hemodynamic status.

Cerebral Oximetry

• Cerebral oximetry, otherwise known as near-infrared spectroscopy (NIRS), measures regional cerebral tissue oxygen saturation (rSO2) at the microvascular level
• provides rSO2 values continuously and noninvasively
Example of repetitive inductions and terminations, to allow for brief entrainment mapping (no mechanical support)
pLVAD Devices: Impella 2,5™
Electromagnetic Interference (EMI)

- Can occur when a magnetic-based mapping system (Carto) is used in conjunction with the magnet-based Impella pLVAD.
- Can occur during sinus rhythm (substrate) and entrainment mapping.
- Locations most likely to result in EMI are adjacent to the outflow tracts.
- The frequency and severity of EMI is relatively predictable.
- Appears to be both a “dose” and distance related phenomenon.

During retrograde mapping, electrical noise on the mapping electrogram channels – presumably because of the proximity of the shaft of the mapping catheter to the pLVAD motor in the proximal aorta.

pLVAD Devices: Tandem Heart™
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pLVAD Devices: Levitronix™, Cardio Help™
Levitronix Centrimag™ pVAD
Peripheral arteries status
pLVAD Devices: iVAC 3L™
pLVAD Devices: iVAC 3L™
pVADs for VT ablation support – Homolka hospital clinical data

- Catheter Approach:
  - Epicardial (sub-xyphoid puncture)
  - Endocardial
    - Retrograde Aortic
    - Transseptal

- pVAD insertion (iVAC 3L; CardioHelp; Centrimag; Tandem Heart)

- CARTO/NavX electroanatomical mapping

- Irrigated RF Ablation Catheter

- Regional High-Density Mapping ("Penta-array" catheter)
CASE REPORT

- 41 y/o man, DCMP (post myocarditis), LV EF 18%; ICD 2010
- Repeated ICD storm December 2010 and January 2011; Incessant VTs since the end of January 2011 pre-shock
- AADs without effect and substrate mapping and ablation procedure in outside hospital January and February 2011
  - LV endocardial mapping
  - Ablation using an irrigated RFA catheter
- Due to incessant VTs → pVAD **Tandem Heart** - hemodynamic support
VTs induced during 1st EPS
1st procedure – epi/endocardial substrate map
2nd procedure – epi/endocardial substrate map

- Two weeks after repeated ICD shocks and incessant VT have been detected
- pVAD *again* was used (Centrimag ECMO)
- General anesthesia, Epi/Endo approach
1st procedure – epi/endocardial substrate map
2nd procedure – epi/endocardial substrate map
Characteristics of the patient group

14 pts (all men) ø age 64.8 y. (T. H.)
12 pts (all men) ø age 71.4 y. (LEVI)
3 pts (all men) ø age 62.6 y. (Cardio Help)
1 pt man age 68 y. (Lifebridge)
3 pts (all men) ø age 63.2 y. (P. C.)
1 pt man age 58 y. (Impella 2,5)
29 pts (all men) ø age 72.4 y. (B. P.)

• ø LV EF 18.1 % pVADs
  25.4 % Balloon Pump

• 42 pts post MI (anterior 24, inferior 10, infero-base 8)
  21 pts DCMP

• all pts with ICD - primary prevention 44
• Arrhythmogenic storm 48
  incessant 15
Characteristics of the patient group

- Time of procedure: Ø 6.7 hours
- Number of VTs: Ø 4 (2 – 10)
- CL of VTs: Ø 291 ms (224 – 526 ms)
- Epicardial approach: 26 pts (1 failure)
- Multispine catheter: 14 pts po IM
- All VT eliminated in: 44 pts (70%)
- VT during procedure: Ø 76 minutes
- Total time on pVAD: Ø 62 hours
- Recurrence of VT: 9 pts (Ø follow-up 34 m.)
  - Heart Mate LVAD: 2 pts
  - Alcohol + Bi RF: 5 pts
CONCLUSION

- Peripheral Ventricular Assist Devices: useful for temporary hemodynamic support during incessant and unstable VT

- They facilitates careful mapping and ablation using a number of strategies:
  - Entrainment mapping
  - Dense mapping of late potentials

- Facilitate high-density mapping of the extensive substrate, help to identify specific potentials and also good entrainment sites

- pVAD for VT ablation remains to be defined with additional experience
• Is the pLVAD approach safe?
  – Peripheral arterial status
  – Arterial insufficiency of critical organs

• How effective is the pLVAD? In which patients should the pLVAD be used?
  – Does the pLVAD improve the success of VT ablation?
  – Cost effectiveness?
  – Will the availability of pLVAD increase VT ablation utilization?
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CONCLUSION - stratification

- Mechanical support system we consider always when patient’s LV EF is less than 25 %
  - LV EF 20 – 25 % → Balloon pump for SR substrate map
  - LV EF 15 – 25 % → pVAD transaortic system (Impella 2,5; iVAC 3 L)
  - LV EF 10 – 20 % → pVAD high output (Centrimag, T.H.)
  - Incessant VT → always high output pVADs
  - „Ultrafast“ VTs, Polymorphic VTs, VF ????