Supraventricular arrhythmias, such as junctional ectopic tachycardia (JET) and atrial fibrillation (AF), frequently complicate recovery from open-heart surgery in children and can be difficult to manage using current approaches. Pharmacologic treatment has been the main strategy for the control of postoperative atrial arrhythmias (AA), but is associated with hypotension, pro-arrhythmia and myocardial dysfunction. There is a need for a reversible, modulated solution to rate control. We propose a non-pharmacologic technique that can modulate AV nodal conduction and automaticity, while still allowing the natural function of the electrical system. In our canine model, direct stimulation of the AV nodal Fat Pad using our novel catheter and control device has been shown to result in rate control acutely.

We demonstrated the efficacy of vagal stimulation at the inferior right fat pad (FP) to slow the ventricular response (VR) of AF and JET. We hypothesized that the VR response to AA could be improved by alterations in 1) the site of stimulation (anterior right FP vs. inferior right FP), 2) site within the two FP regions tested, and 3) whether there was a relationship between stimulation voltage (V) and electrophysiologic effect.

Introduction

Methods

Eight mongrel dogs, age 8.7 ± 3.9 months and weighing 21.5 ± 2.5 kg, underwent open heart surgery replicating Tetralogy of Fallot repair. Stimulation of the anterior right (AR) and inferior right (IR) FP pad was used to control the VR of AF and JET. A 7-pole electrode was sutured to the AR and IR FP and used to deliver stimulation therapy. Tested parameters included: 1) FP site, 2) stimulation pole configuration, and 3) stimulation (1-25) V on the VR to AF and JET. Stimulation frequency was 30 Hz, and pulse width was 0.15 msec.

1). The inferior right FP was more effective in slowing the VR response to AF (-0.43 ± 0.18 vs. -0.18 ± 0.11 %, p = 0.03) and JET (-0.16 ± 0.06 vs. 0.0 ± 0.0, p = 0.06). 2). Selective site stimulation within a FP region could augment the effect of stimulation during AF (-0.48 ± 0.21 (maximum effect) vs. 0.0 ± 0.0 % (least effect), p = 0.01). Stimulation of electrodes 2+3 produced the greatest reduction in HR with a maximum percent VR reduction of 34.8%. 3). FP stimulation at increasing V demonstrated a voltage-dependent effect (-0.12 ± 0.19 (low V) vs. -0.63 ± 0.21 (high V) %, p=0.01).

Results

Conclusions

Selective site stimulation within a fat pad region and optimizing the voltage output enhanced the efficacy of ventricular rate (VR) slowing during post-op AA. Stimulation multiple sites of the inferior right fat pad using combinations of electrodes allowed for maximal slowing of VR. The inferior right fat pad was more effective in decreasing VR during AF, suggesting its role in control of AV node conduction. The anterior right fat pad had little effect on JET compared with the IR FP, suggesting differences in mechanism of action between the two regions. The electrode catheter and pacing device developed here at George Washington University could potentially be used in humans for rate control of JET and AF in the near future.

References