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A Review of Transcatheter Ablation for the Treatment of AVNRT in Children

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Introduction

Atrioventricular nodal reentrant tachycardia (AVNRT) is an arrhythmia due to re-entrant rhythm within the region of the atrioventricular (AV) node, which accounts for most supraventricular tachycardia (SVT) cases in children. The AV node consists of two main pathways involved for the re-entrant rhythm, slow and fast pathways,[1,2] with different anatomic locations and involvement in the circuit associated with AVNRT. In children who are deemed high risk for serious complications of SVT due to AVNRT, ablation techniques which impede the reentrant pathways are often considered.[3]

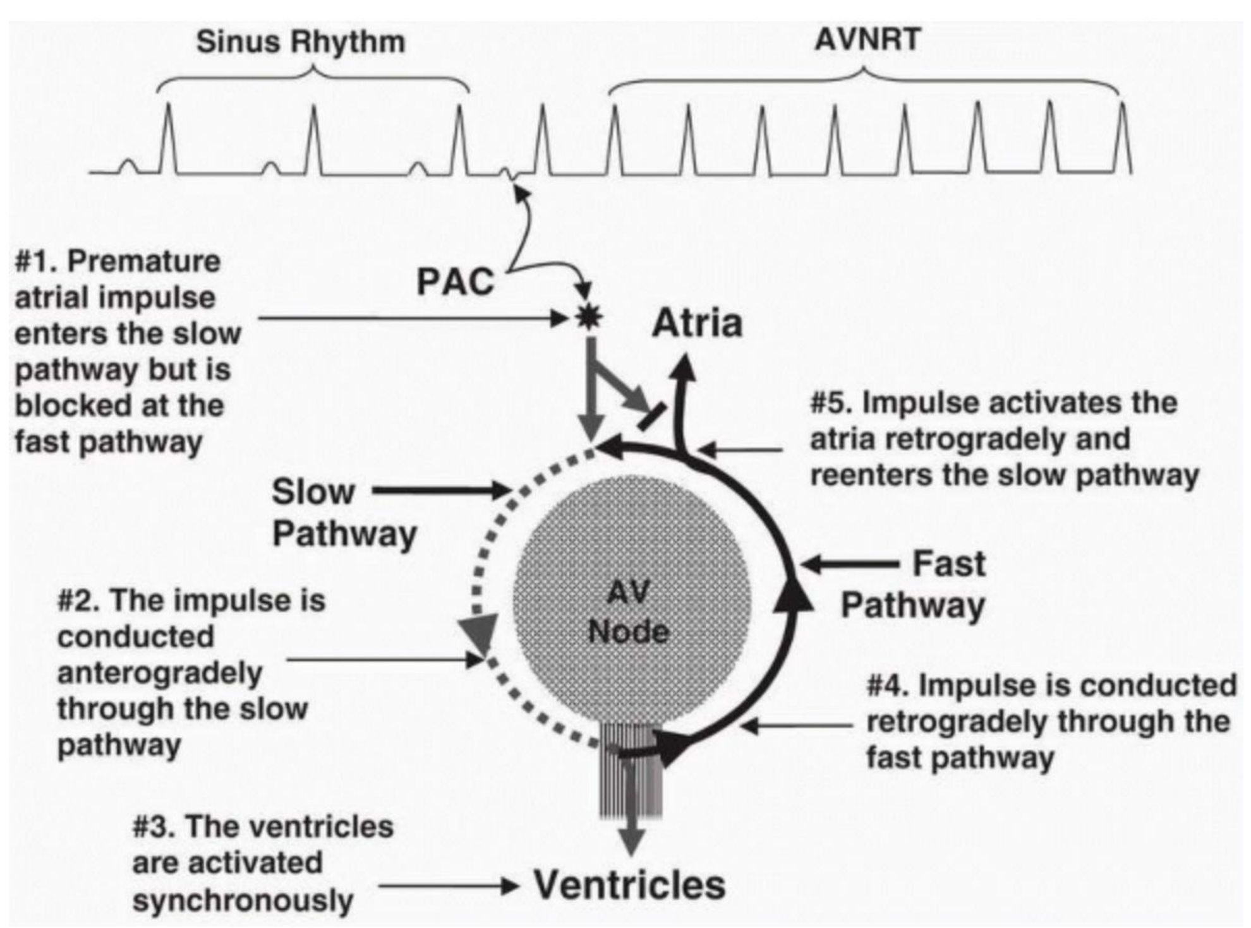

Figure 1: Etiology of AVNRT.[4] AVNRT occurs when an accessory pathway between the atria and ventricles conducts an electrical impulse in the retrograde direction. This impulse continues back to the AV node to stimulate a ventricular contraction earlier than one should happen, as paced by the sinoatrial (SA) node. When this stimulation is repeated by the electrical impulse travelling in a circular pathway, a supraventricular tachycardia occurs.

Catheter Methods

Radiofrequency (RF) ablation [5]

- High energy radio waves transmitted via catheter to cause heating of heart tissue, denaturing proteins in accessory pathway.
- More common method and current gold standard.

Cryoablation [3]

- Catheter is cooled in order to freeze and, thereby, destroy tissue in accessory pathway.
- Tissue can be cooled without reaching freezing point and tissue destruction, in order to "test" whether or not the site needs to be ablated.
  - If improvements are noted in arrhythmia while tissue is cool, it can be further ablated to cause freezing and permanent tissue damage.
  - If no improvements observed, tissue can be thawed without leaving permanent damage.

Complications

RF ablation and Cryoablation carry similar risk profiles with adverse effects, and complications can occur during any part of the procedure.[6] Still, the risk of complications is minimal at 2.9%, with the majority of complications arising from the invasive electrophysiology performed concurrently, rather than from the ablation itself.[3,6] The most concerning and common type of major complication of RF ablation of AVNRT is inadvertent complete AV block.[6]

- Ablations performed using anterior, rather than posterior, approach had higher incidences of complete AV block. Higher risk rates reported in pediatric population.[1]
- Cryoablation less associated with complete AV block, but had a higher ablation device failure occurrence.[7]
- No associated deaths from complete AV block caused by RF ablation
- Higher risks and complication rates may be increased in patients with anatomic variants or multiple accessory pathways.[8] Reducing risks and complications in these patients through contact mapping with the goal of creating 3D voltage maps of the heart is an area of active research.[9-11]

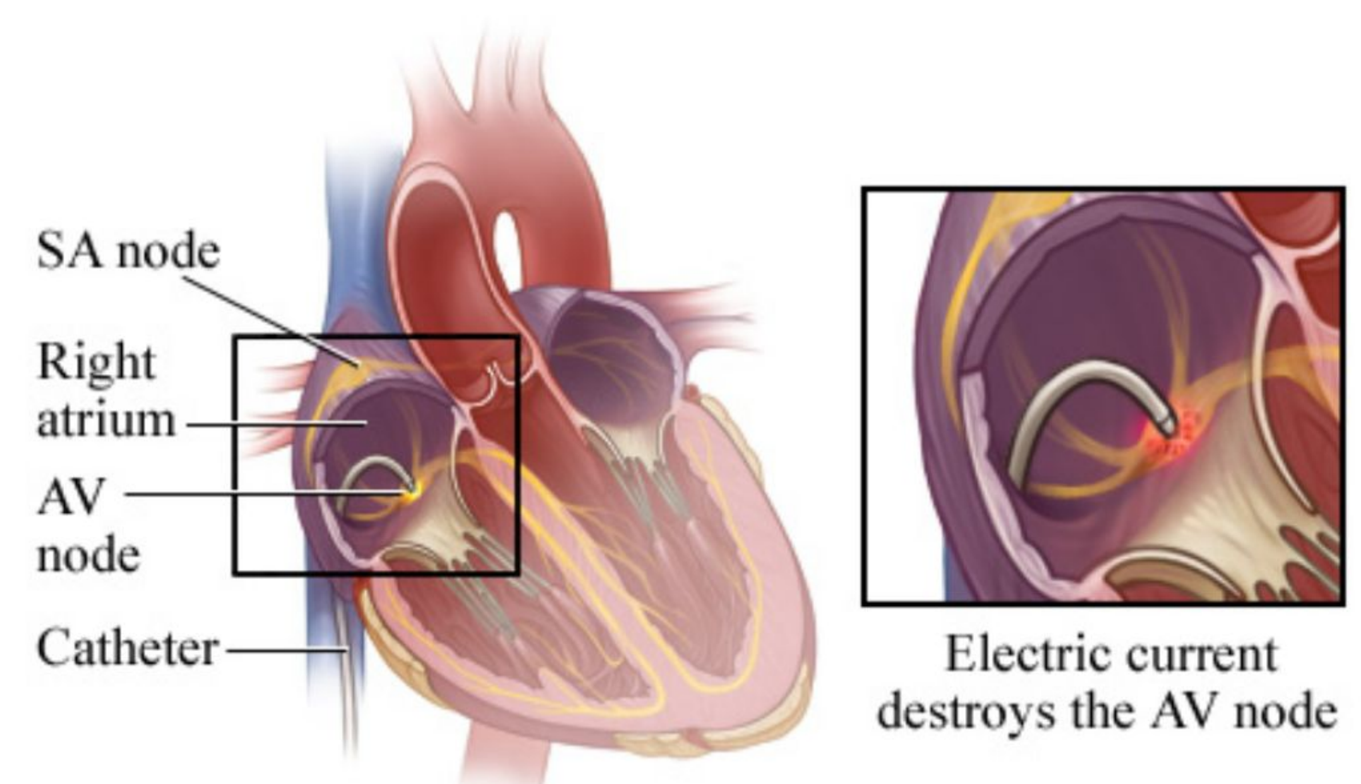

Figure 2: Destruction of AV Node.[12] The AV node is located at the apex of Koch's triangle[13], an anatomical landmark for cardiac procedures, located with the right atrium.[14] While not as much of a complication in adults, the growing and developing heart of a child could alter the length of Koch's Triangle potentially leading to AV injury during ablation or later AVNRT recurrence after treatment.[13]

Long-term safety and efficacy

A comparison of drugs to ablation therapy consistently shows ablation is the preferred method of treatment for AVNRT. Pharmacologic therapies, such as Calcium Channel Blockers (i.e.verapamil, diltiazem), are used as preventative measures during an AVNRT episode, but have associated adverse effects,, especially during long-term drug therapy.[15] Cardiac ablation is the preferred long-term treatment option, as its safety and efficacy still make it an alternative to pharmacological treatment, rather than a second-line therapy.

Conclusion

RF ablation remains the gold standard for treatment of AVNRT in the pediatric population with very high success rates. Radiofrequency and cryoablation techniques both have a similarly low complication risk profile. While RF ablation in children is associated with lower long term risk of recurrence, it may carry a higher risk of the most common major complication--inadvertent complete AV block. The cessation of RF ablation with concurrent development of junctional rhythm and then verification of AV nodal conduction shows promise in reducing these adverse events, but more research is needed in this area.[6]

Cryoablation is an emerging technique that should be considered in the pediatric population, especially in the case of anatomical variants, multiple re-entrant pathways, and in cases where fluoroscopy must be limited or is contraindicated. In the case of anatomical variants or multiple pathways, cryoablation may be superior to RF ablation by offering the ability to check if the correct and optimal tissue is being ablated. It also offers a reduced fluoroscopy time, and therefore delivers lower doses of radiation to the susceptible pediatric population. As newer methods for ablation come into more widespread use, it is likely that outcomes for children with AVNRT will continue to improve.

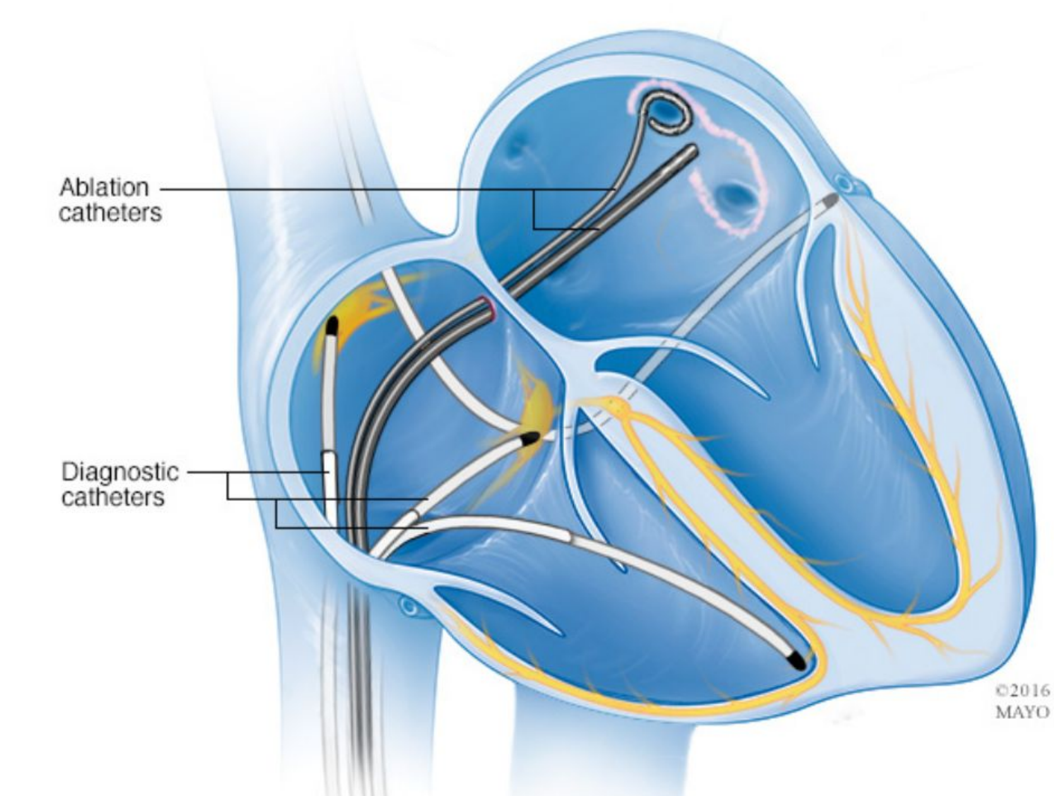

Figure 3: Cardiac ablation.[16] Ablation is an invasive procedure that interrupts the electrical pathway that causes the arrhythmia.[17,18]

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