Ablation of Atrial Arrhythmias in Postoperative Congenital Heart Disease Patients

Have We Reached the Upper Limit of Success or Is It Time for a Paradigm Shift in Strategy?

See Article by Klehs et al

Jeffrey P. Moak, MD

Development of sustained atrial arrhythmias in patients with congenital heart disease (CHD) becomes more common years after successful anatomic repair despite early decreases in hemodynamic burden on the heart after surgical repair.[1] Surgical incisions required to open the heart to allow access to holes and abnormal valve anatomy may be associated with atrial arrhythmias in the early postoperative period. More commonly, these incisions set-up boundaries of slow conduction or regions of conduction block that facilitate the occurrence of either focal or reentrant atrial arrhythmias as described in the report by Klehs et al.[2] The average time to onset of these arrhythmias was 22±12 years in this study, similar to previous reports.[1,3,4] One may ask, why so long after surgery?

Patients presenting with atrial tachycardia (AT) may be asymptomatic as noted in 27 of 144 (19%) of the study patients or have a more concerning clinical presentation with palpitations, dyspnea, chest pain, or syncope.[1] For those with implantable cardioverter defibrillators, atrial arrhythmias are one of the more common triggers for inappropriate shocks. Less commonly, sudden cardiac arrest may be the first sign of presentation.[5]

Once faced with a patient with sustained AT, the clinician must decide on what form of treatment might be best. Choices include antiarrhythmic drug treatment, antitachycardia pacing, or ablation. Although radiofrequency ablation of the tachycardia substrate has been endorsed in the 2014 PACES (Pediatric and Congenital Electrophysiology Society) consensus document,[6] this decision would seem appropriate if ablation had a higher success rate and lower complication rate in the long-term than does antiarrhythmic drug therapy, but how do the 2 approaches really stack up? Klehs et al[2] report a 54% recurrence rate after a seemingly successful ablation procedure, with 75% of the recurrences occurring in the first year.[2] These results do not seem on the surface so much better than pharmacological treatment. Efficacy of treatment with sotalol and dofetilide in the medium term in small numbers of reported adult patients with CHD varies between 41% and 68%.[7–9] All being equal, which may not be the case, and ablation (if successful) has the advantage of not requiring daily administration of medication, and possible concomitant adverse hemodynamic and electrophysiological effects these medications have on sinus and atrioventricular nodal function, in addition to prolongation of the QT interval and facilitation of ventricular proarrhythmia. Amiodarone, although effective in managing these arrhythmias, is not an ideal long-term solution in a young individual secondary to the known long list of potential multiorgan drug-induced toxicity of amiodarone.[9]

Are the medium-term ablation results reported by the Gottingen group comparable with other recent studies using radiofrequency ablation to manage AT in adults with CHD? Other recent reported series suggest a higher long-term success

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Correspondence to: Jeffrey P. Moak, MD, Division of Cardiology, Children's National Health System, 111 Michigan Ave, NW, Washington, DC 20010. E-mail jmoak@childrensnational.org

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rate than reported by Klehs et al,[2] ranging from 75% to 92%.[10,11] Since its early inception as reported 2 decades ago by Triedman et al,[3] radiofrequency ablation of AT has become more effective in treating sustained atrial arrhythmias in CHD. These early investigators reported a 36% long-term AT success rate although a higher percentage of patients had fewer arrhythmia recurrences post-ablation. Improvements in mapping techniques, 3-dimensional contact mapping, irrigated catheter technology, and remote navigation, have built on the initial success of the Boston experience.

Although the authors' definition of CHD complexity comes from 2008 American Heart Association/American College of Cardiology guidelines,[12] I would question the appropriateness of this classification for dividing different CHDs from an electrophysiological perspective. For example, how is AT ablation in a patient with repaired valvular pulmonary stenosis and coarctation of the aorta any more complex than a ventricular septal defect? We know that the ablation of AT is pretty similar when the right atrium and left atrium are for the most part anatomically normal. The real complex lesions are d-transposition of the great arteries and single ventricle anatomy.[4,13,14] I would have rather seen the authors either group the data by similar lesions (tetralogy of Fallot, pulmonary atresia, or truncus arteriosus) or devise their own electrophysiological classification of complexity rather than distribute similar atrial anatomies among different complexity groups derived from the hemodynamic impact of the specific congenital heart defect.

Like all good studies, the Gottingen group's data point us in the right direction but open the door to questions beyond what the study data can tell us. What lessons does their article teach us?

1. Complexity matters, not so much as determined from the Warnes et al[12] classification of adult CHD, but in those with d-TGA and single ventricle anatomy. Acute success was statistically lower in these patient subsets.
2. Electrophysiological substrate matters. The presence of multiple unstable atrial reentrant circuits or noninducibility as seen in 27 of 144 of the patients (presumably but not specifically addressed in the article) is associated with a higher AT recurrence rate. Termination of AT origin in the left or pulmonary venous atrium (57%) was significantly lower than in the right or systemic venous atrium (83%).
3. Comparison of mapping and ablation techniques. Noncontact mapping was associated with a lower acute success rate, reinforcing the generally-held believe that contact mapping more precisely defines regions of slow or abnormal conduction than does tissue characterization based on mathematically derived atrial electrograms.[15]

A separate publication from the Gottingen group demonstrated that catheter technology incorporating contact force of the catheter tip may not augment the long-term success rate of AT ablation.[16] Having the ability to crucially assess the impact of new technologies on AT ablation success in the CHD population is cardinally in advancing this field as we see in the Gottingen group's publications.[2,16] Most of the reported outcome studies from adult CHD AT ablation include relatively small numbers of patients, making it difficult to elucidate definitive conclusions from the reported data. In contrast, electrophysiology centers in Spain have successfully joined together to pool their ablation data into a country-wide ablation registry, allowing for rapid and critical assessment of outcome results.[17] I would propose, like we see in this collaborative Spanish registry, establishment of an adult CHD AT ablation registry to allow investigators to compare different techniques in larger number of patients, possibly shortening the time for assessing new technologies. For example, remote catheter navigation may augment the success rate,[9] but only limited number of adult CHD have been reported in published data. Other technologies on the horizon include magnetic resonance imaging–guided ablation to assess underlying substrate and the effectiveness of applied ablation lesions in altering atrial tissue architecture.[18]

Registry data may allow other important questions to be addressed that may result in a fresher understanding of the atrial arrhythmia substrate. In patients who undergo repeat procedures, is the substrate similar, representing simple recurrence of conduction across ablation lines (which may be a technique or technical failure) or has there been development or creation by the original ablation lines of a new substrate?

Have we failed to learn from our surgical colleagues? Are right atrial or biatrial Maze procedures more effective than the percutaneous catheter ablation approach? Some studies suggest so, but others report outcomes similar to the transvenous technique.[19,20] A comprehensive AT ablation registry would allow for this type of comparative analysis. Dissecting out the different anatomies and their ablation outcome is nearly impossible from reviewing currently published surgical reports.

Percutaneous catheter ablation of postoperative AT as currently practiced may have a less than desired ceiling of success, intrinsically limited by the nature of our tools and current approach. The current paradigm is to define scar responsible for sustained atrial reentry for a single spontaneous or electrophysiologically induced arrhythmia. Other sites of scar which maybe noted during the mapping procedure are for the most ignored if not at the time of the index ablation procedure thought responsible for a specific arrhythmia circuit. Furthermore, little to no thought is given to the potential proarrhythmic impact of ablation lines in creating future

reentry circuits. As intentional designed and executed in the surgical Maze approach, a more thorough and complete set of lesions is applied that may prevent future AT circuits created by the first ablation procedure or treat other potential circuits that are just not seen at the time of the first procedure.[19,20] For example, Klehs et al[2] found that AT was not inducible in 19% of their patient cohort, leaving the operator unclear as to the substrate responsible for the patient's clinical arrhythmia. It would have been interesting to know the ablation outcome in the subset of patients in whom an empirical ablation approach was practiced. Data from patients undergoing repeat AT ablation procedures suggest that a new circuit is more common that recovery of the first ablated arrhythmia circuit.[21] Upping ablation success for intra-atrial reentry tachycardia might require a strategy of more thorough assessment of atrial scar, as reported by the Utah group.[18] Ablation lesions incorporating all potential scar as identified by electroanatomic mapping and tissue characterization using magnetic resonance imaging–defined delayed enhancement may be the road to the next higher level of success.

AFFILIATIONS

From the Division of Cardiology, Children's National Health System, Washington, DC.

DISCLOSURES

None.

FOOTNOTES

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Jeffrey P. Moak

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