Time course of sinus node function recovery in patients with sinus node dysfunction noted immediately after congenital heart surgery.

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Introduction:

Surgery for congenital heart defects in children and young adults may be followed by immediate and significant sinus node dysfunction (SND) (1-3). The cause of such SND is unclear but may involve a variety of mechanisms including: direct trauma to the sinus node, damage to the sinus node artery; stretching of the sinus node during dissection/retraction, and edema from handling the area near the sinus node (1-3).

In some cases, the SND resolves over the immediate post-operative period (traditionally defined as either 30 days or prior to hospital discharge) while in others it does not (3). Temporary SND is thought to be caused by minor trauma, stretching or edema while those with permanent SND are considered to have had more severe trauma to the sinus node or its artery. Unfortunately, there is, as yet, no simple way to determine whether the damage is mild and recoverable/transient or severe and permanent or a priori, predict which patient is likely to recover.

SND is seen after certain surgeries such as the Fontan operation or baffling procedures within the atrium (historical operations like the atrial baffle operation or current operations in certain complex systemic or pulmonary venous anomalies) (1-3). However, SND can occur after any procedure that is near the sinus node or its artery.

Current guidelines on pacing in children and adolescents state that pacing is appropriate for SND in the presence of symptoms and bradycardia for age or pauses >3 seconds. In addition, patients with and without symptoms whose resting heart rate is below 35 are also considered appropriate candidates. Symptoms can be hard to define in the immediate post-operative period. However, bradycardia for age (see below) with hemodynamic compromise (lower than desired blood pressure, urine output, peripheral perfusion, acidosis, etc.) may be considered significant SND.

In general, management of SND in the early post-op period is by pacing the atrium using temporary pacing wires placed at the time of surgery while awaiting sinus node recovery.

The length of time that these patients should be paced temporarily while awaiting sinus node recovery is unclear.

This proposed study will be a prospective multi-center study, and will aim to answer the question: how long should one wait before placement of a permanent pacemaker for SND?

Or put another way, what is a reasonable time frame within which sinus node recovery can be expected in patients where it presumably has not been irretrievably damaged?

Specific Aims:

1. To ascertain the time course of recovery (or lack of recovery) in patients demonstrating severe SND (as defined below) immediately after surgery for congenital heart disease.

Methods:

This study will be a multi-center prospective data collection coordinated from OHSU.

We will contact the membership of PACES (Pediatric and Adult Congenital Electrophysiology Society) and invite all members to consider participating in the study. All centers participating will obtain local IRB approval before enrollment.

Centers will be asked to enter their data into a data repository (Redcap).

All patients, regardless of age, undergoing surgery for congenital heart disease who show signs of severe SND (see definition below) and need for temporary atrial pacing will be included.

Since, in the current era, the patients who appear to be at highest risk for SND are those undergoing the Fontan operation, all patients undergoing the Fontan operation will be asked to undergo a 24 hour Holter monitor within the 3 months prior to their surgery to evaluate their sinus node function. This is the standard of care in many institutions.

Exclusions:

1. Patients with preexisting atrial or dual chamber pacemakers.
2. Patients who also show atroventricular dysfunction and need ventricular or dual chamber pacing.
3. Patients with bifascicluar block and prolonged PR interval who may be under consideration for a pacemaker for atrioventricular conduction reasons.
4. Patients with junctional ectopic tachycardia.
5. Patients who are being treated with a class 1 or class 3 anti-arrhythmic medications for a tachyarrhythmia.

6. Patients with heterotaxy syndrome as their underlying diagnosis, a population with a high burden of intrinsic SND or even the absence of a sinus node.

The main data points to be collected will be a determination of the patient's underlying rhythm at each of the following time points:

1. Every day for the first post-operative week.
2. Then no less than weekly until discharge from hospital (can be more frequent at the clinical team's discretion).
3. Then at every follow up cardiology/cardiovascular surgery clinical evaluation after surgery for the next 6 months.

The patient's underlying rhythm will be checked by turning down the patient's atrial pacing rate gradually by no more than 10 beats per minute at a time.

The decision to implant and the timing of implantation of a permanent pacemaker will be at the discretion of the clinical team caring for the patient.

End Points and definitions:

SND: For the purpose of this study, SND will be defined as presence of sinus bradycardia and hemodynamic compromise (as determined by the post-operative clinicians) or symptoms; persistent heart rate < 90 in children under 2 years of age, < 80 between 2-5 years, < 70 between 5-12 years and < 60 between 12-15 years of age. For children 16 and older, a heart rate under 50 beats per minute will be used. Patients with junctional rhythm and hemodynamic compromise will be defined as having sick sinus syndrome if atrial pacing improves their clinical condition or symptoms. If the patient becomes symptomatic with breathlessness, dizziness or chest pain when the atrial pacing rate is turned down, the patient will be determined as having evidence for SND (symptomatic without a pacemaker).

Permanent SND: If, at the 6 month post-operative check, the patient still has SND as defined above, the patient will be labelled as having permanent SND.

Transient SND: All patients who received temporary pacing in the immediate post-operative period and in whom a permanent atrial pacemaker was not placed prior to discharge because of improvement in sinus rhythm to parameters outside those defined above, or, if a permanent pacemaker was placed, and then demonstrate recovery of sinus node function within the ensuing 6 months will be determined to have had transient SND.

For data to be collected, please see below for data collection form.

Consent form:

The protocol will require a consent form signed by the patient or the patient's legal representative/guardian (parent in most instances). An assent will be obtained in all age-appropriate children.

Risks:

Abrupt cessation of pacing can cause severe bradycardia or pauses. Therefore this will not be done at any of the checks. Gradual decrease in the atrial paced rate as described above to ascertain the underlying rhythm may also cause transient bradycardia and hypotension. However, this is a maneuver that is performed regularly in patients with a temporary or permanent pacemaker. As mentioned above, if the patient becomes symptomatic with breathlessness, dizziness or chest pain when the atrial pacing rate is turned down, the maneuver will be discontinued and the patient will be determined as having evidence for SND (based on the presence of symptoms when not paced).

Since all other care decisions will be based on the team caring for the patient from a clinical standpoint, we do not anticipate any other risks.

Confidentiality risks: this is a multi-center study.

All data containing patient identifiers such as name, date of birth etc. will be retained at the patient's clinical team site. No patient identifiers will be transmitted to the coordinating site. All patients will receive a unique identifier to be determined by the data collecting site (for instance patients whose data is collected at OHSU will be labelled OHSU01, etc. this unique identifier will be the only label used to identify the patient to the coordinating site and other sites.

Benefits of the Study:

The patient will derive no personal benefit from this research study. Their clinical care will not be impacted by this study.

We currently do not know the optimal timing of permanent pacemaker placement in patients with SND noted immediately after congenital heart surgery. During the immediate post-operative period, while the patient is exhibiting signs of SND, and is paced for this, the patient has to remain in hospital (in many institutions in the ICU setting). If this study demonstrates that most patients will not recover sinus node function beyond a certain time period (for example one week post-operatively), placement of a permanent pacemaker could be undertaken at an earlier date thus shortening hospital length of stay with a concomitant decrease in medical risk (infection etc.) and cost.

If however, most patients do not recover sinus node function for weeks, (say for example 4 weeks), one may be able to avoid placing a permanent pacemaker in some/many patients by waiting that period of time in hospital and thereby avoid the unnecessary surgery for pacemaker implantation in many who would otherwise have receive a pacemaker.

So, regardless of the findings, this study would have a major impact on the care and cost of care for patients with post-surgical sinus node dysfunction.

References:

1. Greenwood RD, Rosenthal A, Sloss LJ, LaCorte M, Nadas AS. Sick sinus syndrome after surgery for congenital heart disease. Circulation 1975; 52: 208-213.

2. Gewellig M, Cullen S, Mertens B, Lesaffre E, Deanfield J. Risk factors for arrhythmia and death after Mustard operation for simple transposition of the great arteries. Circulation 1991; 84 (suppl):III-187–III-192.
3. Balaji S; Daga A; Bradley DJ; Etheridge SP; Law IH; Batra AS; Sanatani S; Singh AK; Gajewski KK; Tsao S; Singh HR; Tisma-Dupanovic S; Tateno S; Takamuro M; Nakajima H; Roos-Hesselink JW; Shah M. An International Multi-Center Study Comparing Arrhythmia Prevalence between the Intracardiac Lateral Tunnel and the Extracardiac Conduit type of Fontan Operations. J Thorac Cardiovasc Surg. 2014; 148:576-81.

Data collection sheet

1. Unique identifier of patient
2. Patient's month and year of birth
3. Gender,
4. Age at the time of surgery,
5. Underlying structural cardiac diagnosis
6. The surgery which the patient underwent.
7. Prior surgeries Yes/No
8. Surgery # 1
9. Age at surgery 1.
10. Surgery # 2.
11. Age at surgery 2
12. Surgery # 3
13. Age at surgery 3
14. Initial post-operative rhythm prior to temporary pacing.
15. Initial post-operative rate prior to temporary pacing.
16. The rate at which the patient was paced in the atrium while awaiting sinus node recovery.
17. Underlying rhythm day 2
18. Underlying rate day 2
19. Underlying rhythm day 3
20. Underlying rate day 3
21. Underlying rhythm day 4
22. Underlying rate day 4
23. Underlying rhythm day 5
24. Underlying rate day 5
25. Underlying rhythm day 6
26. Underlying rate day 7
27. Underlying rhythm day 7
28. Underlying rate day 7
29. Underlying rhythm day ___
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45. Underlying rhythm day ___
46. Underlying rate day ___
47. Underlying rhythm day ___
48. Underlying rate day ___
49. Underlying rhythm day ___
50. Underlying rate day ___
51. Underlying rhythm 3 months post-op
52. Underlying rate 3 months post-op
53. Is the patient pacemaker dependent (underlying rhythm < 30 bpm) at 3 months
54. Underlying rhythm 6 months post-op
55. Underlying rate 6 months post-op
56. Is the patient pacemaker dependent (underlying rhythm < 30 bpm) at 6 months
57. Interval between initial surgery and date of permanent pacemaker implantation:
58. Method of permanent pacemaker implantation for the SND; whether endocardial vs epicardial and location of the pacing lead.
59. Presence of drugs that could influence sinus node function such as beta blockers, calcium channel blockers or any other anti-arrhythmic drug. Elaborate.
60. Single or dual chamber device
61. Atrial anti-tachycardia capabilities of the device?
62. MRI compatibility of the device.