Does Warden’s procedure reduce sinus node dysfunction after surgery for partial anomalous pulmonary venous connection?

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Abstract

A best evidence topic in cardiothoracic surgery was written according to a structured protocol. The question addressed was ’Does Warden’s procedure reduce sinus node dysfunction (SND) after surgery for partial anomalous pulmonary venous connection?’ Altogether 101 papers were found using the reported search; of which 10 papers provided the best evidence to answer the question. The authors, journal, date and country of publication, patient group studied, study type, relevant outcomes, length of follow-up and results of these studies were tabulated. There was a particular reference to Warden’s procedure, avoidance of incision across the cavoatrial junction and the postoperative sinus node status. There was a direct reference to the adoption of Warden’s procedure in nine studies while one study emphasized the careful use of incision across the cavoatrial junction as a way of averting postoperative SND. The evidence supports the notion that preservation of the sinus node and its blood supply through the adoption of Warden’s technique results in near-absent SND during long-term follow-up. The incidence of SND ranged from 0 to 6.5% when Warden’s procedure was used, increasing to 18.1% when the atrial incision was extended across the cavoatrial junction into the superior vena cava and reaching as high as 55% in double-patch repair. The study limitations include the lack of randomized controlled trial, absence of 24 h Holter monitoring in most of the patients and shorter periods of follow-up.

Keywords: Sinus node dysfunction • Warden’s procedure • Partial anomalous pulmonary venous connection • Cavoatrial junction

INTRODUCTION

A best evidence topic was constructed according to a structured protocol. This protocol is fully described in ICVTS [1].

THREE PART QUESTION

In patients undergoing surgery for partial anomalous pulmonary venous connection, does the Warden’s procedure reduce sinus node dysfunction in the postoperative period?

CLINICAL SCENARIOS

You have just operated on a child with partial anomalous pulmonary venous connection (PAPVC), and unfortunately on the third postoperative day it seems that the conduction system has been damaged again. You recall a similar incident 6 months earlier. You talk to colleagues and they tell you that you are probably not incising across the cavoatrial junction correctly. You decide on a literature search to investigate the problem.

SEARCH STRATEGY

The English language literature was reviewed by searching Medline from 1960 through November 2011 using the PubMed interface.

[Warden’s procedure/OR sinus rhythm.mp/OR repair of PAPVC/OR caval division techniques in PAPVC/OR Sinus node dysfunction] AND [outcome].

The ‘related articles’ function was used to broaden the search and all abstracts, studies and citations scanned were reviewed. The reference lists of articles found through these searches were also reviewed for relevant articles.

SEARCH OUTCOME

One hundred and one papers were found using the reported search. From these, 10 papers provided the best evidence to answer the question. There was a particular reference to cavoatrial junction, choice of incision, Warden’s procedure and postoperative sinus node status. The results are summarized in Table 1.

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Table 1: Best evidence papers

<table>
<thead>
<tr>
<th>Author, date, journal, country Study type (level of evidence)</th>
<th>Patient group</th>
<th>Key results</th>
<th>Length of follow-up</th>
<th>Comments/weakness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agarwal et al. (2011), Heart Lung Circ, India [2] Retrospective (level II-3)</td>
<td>58 patients with sinus venous ASD with PAPVC had Warden's procedure</td>
<td>Postoperative electrophysiological studies showed NSR during follow-up</td>
<td>2.1 years (range, 1 month–2.8 years)</td>
<td>Largest series in literature to date; Short follow up; Not randomized</td>
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<tr>
<td>Stewart et al. (2007), Ann Thorac Surg USA [3] Retrospective (level II-3)</td>
<td>52 patients with sinus venous ASD with PAPVC 24 had single patch repair 25 had two-patch repair, 5 had Warden's procedure</td>
<td>No SND in any of the patients with Warden's technique whilst 25% SND in single patch repair and 55% in double patch repair 2 mild SVC stenosis for double patch, 1 for single patch and severe SVC for Warden's technique.</td>
<td>Follow-up not stated</td>
<td>Compared Warden's procedure with other techniques; Small sample size; No 24 h Holter monitoring; No follow-up done</td>
</tr>
<tr>
<td>Shahriari et al. (2006), Ann Thorac Surg, USA [4] Retrospective (level II-3)</td>
<td>54 patients with sinus venous ASD with PAPVC 13 (24%) had Warden's technique</td>
<td>All patients were in NSR at short term, but 1 patient had PVO at long term</td>
<td>4.3 years (1–13 years)</td>
<td>Longer follow-up; No 24 h Holter monitoring; Follow-up for larger number of patients was lacking</td>
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<td>DiBardino et al. (2004), Cardiol Young, USA [5] Retrospective (level II-3)</td>
<td>16 patients with sinus venous ASD with PAPVC had Warden's technique</td>
<td>1 patient with an episode of sinus bradycardia with intermittent junctional rhythm which resolved spontaneously</td>
<td>Follow-up was up to 5.6 years</td>
<td>Small sample size; Single institutional study; No 24 h Holter monitoring; Follow-up for larger number of patients was lacking</td>
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<tr>
<td>Kottayil et al. (2011), Eur J Cardiothorac Surg, India [6] Retrospective (level II-3)</td>
<td>32 patients had Warden's procedure</td>
<td>1 patient had transient rhythm disturbance All had NSR at longer follow up</td>
<td>A median follow-up of 24 months</td>
<td>Not randomized study; No 24 h Holter monitoring; Short follow-up</td>
</tr>
<tr>
<td>Gustafson et al. (1995), Ann Thorac Surg, USA [7] Retrospective (level II-3)</td>
<td>40 patients with sinus venous ASD with PAPVC had procedure to minimize trauma to SA node</td>
<td>1 patient had SSS but non-required pacemaker</td>
<td>6 months to 30 years</td>
<td>Longer follow-up of 30 years; No 24 h Holter monitoring</td>
</tr>
<tr>
<td>Park et al. (2011), Eur J Cardiothorac Surg, Korea [8] Retrospective (level II-3)</td>
<td>30 patients with sinus venous ASD with PAPVC had Warden's technique</td>
<td>1 patient had transient postoperative SND All patients were in NSR. At long term, 1 patient had PVO, 3 had SVC obstruction</td>
<td>5.3 ± 5.1 years (1 month–16 years)</td>
<td>Explicit follow-up which is longer also; No 24 h Holter monitoring</td>
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<tr>
<td>Nakahira et al. (2006), Ann Thorac Surg, Japan [9] Retrospective (level II-3)</td>
<td>20 of 51 patients had Warden's procedure</td>
<td>All patients were in NSR At long term, 2 patients with persistent LSVC had SVC obstruction</td>
<td>Follow-up averaged 6.5 years</td>
<td>No 24 h Holter monitoring; Follow-up not explicit</td>
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<td>Buz et al. (2009), Ann Thorac Surg [10], Germany 2009 Retrospective (level II-3)</td>
<td>2 groups of patients Group 1 (61) had rerouting of pulmonary veins Group 2 (54) had incision across the cavoatrial junction</td>
<td>New onset nodal rhythm and atrial dysrrhythmias was 26.5% in Group 1 and 54.55 in Group 2, P &lt; 0.004 At long-term follow-up, the rate of arrhythmias was 6.25% in Group 1 versus 18.1% in Group 2</td>
<td>At 1-year follow-up</td>
<td>Comparative study; No 24 h Holter monitoring</td>
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Continued
RESULTS

Agarwal et al. [2] retrospectively analysed 58 patients undergoing Warden’s procedure for PAPVC. The study [2] represented the largest series of reported cases in the literature. None of their patients experienced sinus node dysfunction (SND) on follow-up, which included electrophysiological studies.

Stewart et al. [3] stated that their surgical strategy for repair of sinus venous atrial septal defect (ASD) evolved chiefly to avoid SND. They reviewed their experience with the single-patch, two-patch and Warden repairs. The incidence of rhythm change from sinus to low atrial or junctional rhythm was 35% and was significantly greater among patients with two-patch repair (12 of 22, 55%) compared with single-patch repair (5 of 21, 24%), or the Warden repair (0 of 5, \(P = 0.02\)) which completely avoided incision across the cavoatrial junction. The use of the two-patch technique was associated with a significantly greater incidence of SND.

Shahriari et al. [4] retrospectively compared their experience with the use of the internal patch versus Warden’s technique in the repair of sinus venous ASD with high PAPVC, and observed that it was complicated by SND when the internal patch was used whereas no such complication was observed when Warden’s procedure was used for 54 patients.

In the report of DiBardino et al. [5], one of their 16 patients developed postoperative sinus bradycardia with intermittent junctional rhythm. The rhythm disturbance resolved spontaneously during temporary atrial pacing; the remainder of the patients was free of SND in the postoperative period.

Kottayil et al. [6] reviewed their experience with Warden’s technique, predominantly in children, for various types of PAPVC to the SVC. Thirty-two patients with PAPVC underwent Warden’s procedure. Twenty-eight patients had PAPVC, while four patients had total anomalous pulmonary venous connection to the SVC. Apart from one patient who experienced a transient rhythm disturbance, all other patients remained free of SND after a median follow-up of 24 months.

Gustafson et al. [7] observed that correction of PAPVC to the superior vena cava (SVC) may be complicated by SND and occasionally necessitates the insertion of a pacemaker. Forty patients underwent an operative approach designed to minimize trauma to the sinus node and its blood supply. All patients remained well over follow-up (6 months to 30 years), though sick sinus syndrome developed late in one patient (2.5%). No patient required pacemaker insertion.

Park et al. [8] retrospectively analysed the outcome of Warden’s procedure for 30 patients undergoing repair of PAPVC. Postoperatively, one patient experienced transient SND; all other patients were in regular sinus rhythm at the latest electrophysiological study. They concluded that Warden’s procedure was a safe and effective surgical option for repair of PAPVC in terms of preserving the sinus node function.

Nakahira et al. [9] noted that the repair of PAPVC to the high portion of the SVC may be complicated by atrial arrhythmia. After a mean follow-up of 6.5 years, all 20 patients who had undergone Warden’s procedure for PAPVC repair were in sinus rhythm. Buz et al. [10] retrospectively reviewed the incidence of arrhythmias following two different techniques for repair of PAPVC. Between 1988 and 2006, 119 patients (61 males, 58 females; aged 5 months to 66 years) with PAPVC to the SVC or the right atrium were analysed. All patients were in sinus rhythm before operation. In 64 patients (Group 1), rerouting of the pulmonary veins was accomplished through a right atriotomy, and in 54 patients (Group 2), the atriotomy incision was extended into the SVC through the cavoatrial junction. Their results showed that new-onset of nodal rhythm and atrial dysrhythmias developed significantly more often in patients with extended incision across the cavoatrial junction (Group 1, 26.5%, versus Group 2, 54.5%; \(P < 0.004\)). At discharge, the rate of dysrhythmias was 14% in Group 1 and 32.7% in Group 2 (\(P < 0.01\)) and at 1-year follow-up of 58 patients, the rate of dysrhythmias was 6.25% in Group 1 versus 18.1% in Group 2. They concluded that extending the atrial incision across the cavoatrial junction increases atrial dysrhythmias.

Gaynor et al. [11] carried out a successful repair in a 7-year old male with a diagnosis of PAPVC to SVC and superior sinus venous ASD. The SVC was divided above the orifice of the anomalous pulmonary vein and the cephalad end anastomosed directly to the right atrial appendage. A patch was used to divert pulmonary venous flow from the orifice of the SVC through superior sinus venous ASD into the left atrium. The postoperative course was uneventful with normal sinus rhythm. Three months after surgery, sinus node function was confirmed to be normal by electrophysiological study.

CLINICAL BOTTOM LINE

The evidence supports the notion that preservation of the sinus node and its blood supply through the adoption of Warden’s...
technique results in near-absent SND during follow-up. The study limitations include the lack of a randomized controlled trial, absence of 24 h Holter monitoring in most of the patients and shorter periods of follow-up.

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