TRENDS IN PREOPERATIVE CARDIAC CATHETERISATION IN CONGENITAL HEART DISEASE

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SUMMARY

Objective: To establish trends in preoperative diagnostic cardiac catheterisation in congenital heart disease (CHD)

Design: Retrospective analysis of performance of catheterisation preoperatively for 1st, 2nd, 3rd and 4th operation for significant and complex CHD.

Setting: Regional hospital providing CHD diagnostic and follow-up services for all Malta.


Main outcome measures: Whether or not preoperative catheterisation was performed.

Results: 651 operations were carried out for CHD between 1947-1994. The proportion of patients undergoing cardiac catheterisation prior to surgery has declined (p=0.0004). Further analysis showed that this trend was due to a reduction in the proportion of patients undergoing catheterisation prior to 1st operation for significant CHD (p<0.0001). This group constituted 75% of all operations. No trends were found in other types of operations.

Conclusions: Echocardiography, a non-invasive technique, has supplanted cardiac catheterisation as the primary diagnostic tool prior to 1st operation for significant CHD. However, catheterisation maintains a role for investigation prior to other operations for CHD.

INTRODUCTION

Congenital heart disease (CHD) is the commonest congenital malformation. The term is a label for a heterogeneous group of lesions with varying haemodynamic consequences and hence, varying need for follow-up and intervention/s. Diagnosis, follow-up and treatment of CHD is expensive. Population based studies are important aids for the planning of future likely requirements since allocation of finite resources is a ubiquitous public health problem.

Malta is a small, central Mediterranean country with a total population of around 370,000 and a birth rate of around 5300 deliveries per annum1. This provides a relatively closed population furnishing an ideal setting for epidemiological and historical studies regarding CHD.

METHODS

Definitions

CHD was defined as a structural abnormality of the heart or intrathoracic great vessels that is actually or potentially of functional significance2. The following conditions were excluded:

1. Arrhythmias, unless accompanying structural abnormalities.
2. Persistent patency of the arterial duct occurring in association with prematurity and which resolved spontaneously or required treatment before 3 months of age.
4. Isolated mitral valve prolapse with or without mitral incompetence.
5. Isolated dextrocardia in the absence of accompanying structural abnormalities.
6. Atrial septal defects that closed spontaneously on follow-up or were shown echocardiographically to be haemodynamically insignificant and therefore would not require intervention.
7. Dilated and hypertrophic cardiomyopathies.

Confirmation and Hierarchy

Cases with multiple CHD diagnoses had their lesions classified hierarchically. The primary lesion was considered that lesion which first required intervention. In cases where no intervention was necessary, the primary lesion was considered that which produced the most haemodynamic disturbance.
CHD was graded by severity to allow broad classification into three groups. Complex CHD included all conditions with valve or chamber atresia or hypoplasia such as hypoplastic left heart syndrome and tricuspid and pulmonary atresia.

Severe CHD included conditions where all cardiac structures were present but surgery or interventional cardiac catheterisation was necessary, or was anticipated to be necessary in future e.g. Ventricular and atrial septal defects, tetralogy of Fallot and transposition of the great arteries.

Mild CHD included all lesions in which no intervention had been done and in which none is planned in future.

**Patients and Population**

All Maltese patients who have undergone surgery for CHD were included in this study. Recent studies dealing with the epidemiology of CHD have only included patients diagnosed by 1 year of age. Due to the historical nature of this study, this condition was not applied.

Operations were classified into those with pre-operative cardiac catheterisation and those without pre-operative cardiac catheterisation. Cardiac catheterisation was divided into 2 types: diagnostic and interventional. Catheters included in this study were pure diagnostic procedures, and interventional catheters in which balloon septostomy was performed. Catheterisation prior to operation was defined in the following way:

For 1st operation – Catheter performed any time prior to operation.

For 2nd operation – Catheter performed after 1st and before 2nd operation.

For 3rd operation – Catheter performed after 2nd and before 3rd operation.

For 4th operation – Catheter performed after 3rd and before 4th operation.

**Data sources**

Sources included children being followed up at Children's Outpatients for CHD with or without other problems, copies of all paediatric echocardiogram reports, lists of locally performed elective cardiac catheters and operations and lists of patients sent abroad for urgent cardiac catheterisation or intervention not available in Malta. In addition, clinic registers of patients seen at visiting consultant paediatric cardiologist clinics which are held 3-4 times a year were examined.

**Database and statistics**

Patients with CHD were entered onto a dedicated database (Maltese Paediatric Cardiology Database). Diagnoses and interventions were coded with a Version 2 Read Codes Browser. A series of programs were used to extract data which was analysed with Excel and Epi-Info. Analysis of trends was performed using the $\chi^2$ test for linear trends. A p value of 0.05 was taken to represent a statistically significant result.

**RESULTS**

A total of 651 operations were carried out in the period 1947-1994 inclusive. There was a significant trend towards an increase in the ratio of catheterised: uncatheterised patients from 0.5 in 1960-64 to 1.1 in 1990-94 ($\chi^2 12.21 - 0=0.0004$).

**Significant CHD**

A total of 579 operative events were carried out for significant CHD over the period 1947-1994. These were subdivided into 1st, 2nd, 3rd and 4th operations for CHD. 491 operations were 1st operations while 88 were 2nd, 3rd and 4th operations (table 1). 1st operations for significant CHD constituted 75% of all operations for CHD.

The numbers of uncatheterised and catheterised operations for 1st operation for significant CHD are shown in figure 1. The ratio of uncatheterised: catheterised operations increased significantly from 0.2 in 1960-64 to 1.4 in 1990-94 ($\chi^2 21.03 - p<0.0001$). Uncatheterised cases were comprised almost exclusively of patent ductus arteriosus and coarctation of the aorta prior to the mid-1980s. Other lesions began to be operated without prior catheterisation after the mid-1980s.

The 5-year totals of uncatheterised and catheterised operations for 2nd, 3rd and 4th operation for significant CHD are displayed summed in figure 2. The ratio of uncatheterised: catheterised operations failed to display any trends ($\chi^2 1.91 - p=0.16$).

**Complex CHD**

A total of 72 operations were carried out for complex CHD, which included 1st, 2nd, 3rd and 4th operations. Due to the small numbers, the 5-year totals of uncatheterised and catheterised operations for all operations for complex CHD were summed and are shown in figure 3. The ratio of uncatheterised: catheterised operations remained unchanged from 0.5 in 1960-64 to 0.5 in 1990-94 ($\chi^2 2.36 - p=0.12$).
Table 1: Surgery for Maltese patients with CHD (1947-1994)

<table>
<thead>
<tr>
<th>Operations</th>
<th>Significant CHD</th>
<th>% of total</th>
<th>Complex CHD</th>
<th>% of total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st</td>
<td>491</td>
<td>75%</td>
<td>34</td>
<td>5%</td>
</tr>
<tr>
<td>2nd</td>
<td>76</td>
<td>12%</td>
<td>22</td>
<td>3%</td>
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<tr>
<td>3rd</td>
<td>11</td>
<td>2%</td>
<td>15</td>
<td>2%</td>
</tr>
<tr>
<td>4th</td>
<td>1</td>
<td>0%</td>
<td>1</td>
<td>0%</td>
</tr>
<tr>
<td></td>
<td>579</td>
<td>89%</td>
<td>72</td>
<td>11%</td>
</tr>
<tr>
<td>Grand total</td>
<td></td>
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</tr>
</tbody>
</table>

Figure 1: Catheterisation prior to 1st operation for Significant CHD

Figure 2: Catheterisation prior to 2nd, 3rd & 4th operation for Significant CHD

Figure 3: Catheterisation prior to 1st, 2nd, 3rd & 4th operation for Complex CHD

DISCUSSION

Malta has strong medical links with the UK which date back to the 1st World War. Although the Maltese Medical School is the second oldest in the world, there are insufficient doctors in training to allow the establishment of local postgraduate examination boards. It has been the custom for the majority of postgraduate trainees to undergo further training and examination in the UK, which has further strengthened the medical links between the two countries. This has led to visiting cardiologists over the past 30 years all being based in England. Hence, the developments in local paediatric cardiology services have run in parallel with services in the UK. The small size of the country enabled all patients diagnosed as having CHD to be identified and entered onto a database by a single person, ensuring complete ascertainment and accuracy of all diagnosed cases. Since diagnostic and interventional decisions were undertaken by the above-mentioned consultants, it is reasonable to assume that the trends found locally can be extrapolated to larger countries.

Significant CHD

Cardiac catheterisation was formerly the only reliable diagnostic test available to the paediatric cardiologist. However, it is an invasive procedure and is not without some risk of morbidity and mortality. This was particularly the case prior to the development of isotonic contrast medium. For this reason, catheterisation was frequently omitted in cases where a diagnosis could be established clinically due to clear physical signs as in coarctation of the aorta and patent ductus arteriosus. Definitive diagnosis would then be established at surgery. The introduction of
echocardiography in the mid-1980s allowed diagnosis to be established non-invasively, and the addition of Doppler measurements and colour-Doppler flow-mapping further augmented the value of this investigation by increasing the information that could be obtained during the procedure. This led to a gradual decline in the need for pre-operative catheterisation for significant CHD which began in the mid-1980s\(^5\). However, catheterisation is still used for the performance of balloon septostomy in transposition of the great arteries with inadequate intracardiac mixing, and to delineate the coronary arteries as in tetralogy of Fallot where complete repair in the region of the right ventricular outflow tract may damage an aberrant coronary artery.

Further operations for significant CHD frequently need catheterisation as these may be done to redo the original operation which may have been partly or wholly unsuccessful. In these situations, it is natural to attempt to gather all of the information possible by any means available prior to reoperation.

**Complex CHD**

Although echocardiography is often sufficient for surgery to be undertaken, some details may not be sufficiently clear. This is particularly the case when details of intrapulmonary vasculature are required such as in pulmonary atresia, as ultrasound cannot penetrate air.

**CONCLUSION**

Echocardiography, a non-invasive diagnostic technique, has supplanted cardiac catheterisation as the sole mode of investigation prior to surgery for the majority of cases of CHD. Cardiac catheterisation remains useful for investigation prior to operations in excess of the first for significant CHD, and for all operations for complex CHD. The role of cardiac catheterisation in these areas has been reduced by transoesophageal echocardiography\(^6\), and may be further decreased by developments of non-invasive techniques such as 3-dimensional echocardiography\(^7\).

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**REFERENCES**