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# Arrhythmias and Conduction Abnormalities after Surgical Repair of Congenital Heart Disease

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***Authors' contributions***

*This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.*

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***Short Research Article***

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## ABSTRACT

**Aims:** To recognize cardiac arrhythmias and conduction abnormalities in children who underwent a surgical repair for congenital heart disease.
**Patients and Methods:** One hundred thirty one (131) patients underwent a surgical repair of congenital heart disease between 2000-2018, and follow-up period after surgery was from two months to eighteen years and our data was collected over 1 year "2018" by interview both children and parents, sixty-four patients (48.8%) were a cyanotic congenital heart disease (ACCHD),sixty-seven patients(51.1%) were cyanotic congenital heart disease (CCHD), (41.9%) were female, (58.1%) were male. Cyanotic congenital heart disease more common in male. These patients were evaluated by ECG to detect conduction abnormalities and arrhythmias, Holter monitoring in symptomatic patient.
**Results:** Types of abnormal heart rhythm found out by ECG, Holter monitoring, significant premature atrial contraction (PAC) in one patient post fontain, atrial fibrillation in two patients with post-operative (ASD) repaired. RBBB occur in 53 patients and was most common among post-operative (TOF) repaired (37 patients). Frequent ventricular ectopic in one patient with

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postoperative (TOF) repaired. Atrial tachycardia in one patient with Epstein anomaly, WPW in two patients with Epstein anomaly, complete heart block in five patients, four of them post operative VSD repaired, one post fontain operation. Symptomatic bradycardia needs pace maker in one patient post fontan operation.

**Conclusions:** The Patient after repair of congenital heart defect needed follow-up for detection of arrhythmias, those with complex defect need more frequent follow-up because they prone more to arrhythmia than those with simple defect with no residual defect.

*Keywords: Congenital heart disease; arrhythmias; Complex Congenital Heart Disease (CCHD); Tetralogy of Fallot (TOF); Ventricular Septal Defect (VSD); Atrial Septal Defect (ASD).*

## 1. INTRODUCTION

After cardiac surgery, arrhythmias are a known complication due to weakening of their heart muscle, thickening, or scarring from prior surgeries. These arrhythmias include SVT, atrial flutter/atrial fibrillation, sinus node dysfunction, junctional rhythm, ventricular tachycardia, and various degrees of heart block [1].

Arrhythmias were classified as junction ectopic tachycardia (JET), supraventricular tachycardia (SVT), premature supraventricular contractions, premature ventricular contractions, third-degree heart block, atrial flutter, sinus bradycardia, junctional escape rhythm, sinus tachycardia, ventricular tachycardia, and ventricular fibrillation. Frequent premature supraventricular or ventricular beats were diagnosed if their number exceeded 10 per minute [2].

Examples of types of simple congenital heart disease, repaired atrial septial defect atrial septal defect (ASD), isolated restrictive ventricular septal defect (VSD), mild pulmonary stenosis (PS), previously ligated ductus arteriosus (PDA).

Examples of types of congenital heart disease of moderate complexity, fallot's tetralogy (TOF), anomalous pulmonary venous drainage (TAPVD), atrioventricular canal defects (AVCD), coarctation of the aorta(COA), Ebstein's anomaly of the tricuspid valve (EA), right ventricular outflow tract obstruction (RVOTO), pulmonary valve disease (moderate or severe), sinus of valsalva aneurysm / fistula.

Examples of types of congenital heart disease of great complexity, cyanotic congenital heart disease like conduits, double-outlet ventricle (DOV), eisenmenger syndrome, fontan procedure, mitral atresia, pulmonary atresia (PA), single ventricle(SV), transposition of the great arteries (TA), tricuspid atresia(TA), truncus arteriosus (TA) [3].

### 1.1 Aims

To recognize cardiac arrhythmias and conduction abnormalities in children who underwent a surgical repair for congenital heart disease.

## 2. PATIENTS AND CLINICAL METHODS

Retrospective study of One hundred thirty- one of Libyan childern underwent a surgical repair of congenital heart disease between 2000-2018. And follow-up period after surgery was from two months to eighteen years and the data collected over 1 year (2018) by interview of both children and parents plus medical record of patient for type of cardiac. Surgical repaired including both complex congenital heart disease (CCHD) and a cyanotic Congenital heart (ACCHD). Those follow-up in outpatient clinic in Benghazi cardiac center and Al- hawari pediatric cardiac clinic. And patients were from Benghazi and from outside Benghazi due to lake of cardiac clinic to follow patients in many cities in eastern part of Libya including Elmarg, Green Mountain, Derna, plus city of Sirt in middle of Libya.

These patients were evaluated by clinical symptoms:-Palpitation, syncope, chest pain and ECG to detect conduction abnormalities and arrhythmias and Holter monitoring in Symptomatic patient

## 3. LIMITATION OF THIS STUDY

Many children especially those with operated simple lesion with no residual lesion especially those from areas away from our hospital, we lost follow up with them and also there are another two hospitals in Benghazi for follow up post-operated children with CHD not included in our study and we hope to include them in another study in near future.

## 4. RESULTS

### 4.1 Atrial Septal Defect (ASD)

As shown in Table 1, 11 patients operated for ASD, 8 (72.7%) of them were females, 3(27.2%) were males. One of ASD was sinuous venosous ASD, and one ASD associated with PDA, another one ASD associated with sever pulmonary stenosis. Two of patients with ASD were Noonan syndrome.

**Table 1. Shows time in year since operation**

| Time in year since operation | No. of parient | % |
|---|---|---|
| Less than 5 year | 8 | 72.7% |
| 5-10 year | 2 | 18.1% |
| More than 10 year | 1 | 9% |

**Table 2. Shows ECG finding**

| ECG finding | | |
|---|---|---|
| Normal ECG | 8 | 72.7% |
| RBBB | 1 | 9% |
| AF | 2 | 18.1% |
| VT | - | 0% |

*AF:-Atrial fibrillation, RBBB Right bundle branch block*

### 4.2 Ventricular Septal Defect (VSD)

25 patients underwent repair of VSD, (17) were males and (8) were females. One patient had significant mitral valve regurgitation, another patient had significant tricuspid regurgitation. 16 patients had isolated VSD, while 6 were had VSD and PDA, and 3 patients had VSD and ASD, see Tables 3, 4.

**Table 3. Shows time in year since operation**

| Time in year since operation | No. of parient | % |
|---|---|---|
| Less than 5 year | 15 | 60% |
| 5-10 year | 7 | 28% |
| More than 10 year | 3 | 12% |

**Table 4. Shows ECG finding**

| ECG finding | No. of parient | % |
|---|---|---|
| Normal ECG | 15 | 60% |
| RBBB | 7 | 28% |
| CHB | 3 | 12% |

*CHB:-complete heart block, AF: - Atrial fibrillation, RBBB Right bundle branch block*

Two patients had complete heart block with permanent pace maker third patient with pacemaker return back to sinus rhythms. Holter monitor in 2 patient 1 had RBBB with short PR interval anther one with first degree heart block and attack of supraventricular tachycardia.

### 4.3 Atrioventricular Septal Defects

As shown in Table 5, 15 patients, 13 were with Down syndrome (86.6%) and 2 patients were normal child (13.3%). 10 males (66.6%) and 5 females (33.3%.).

**Table 5. Shows time in year since operation**

| Time in year since operation | No. of parient | % |
|---|---|---|
| Less than 5 year | 11 | 73.3% |
| 5-10 year | 4 | 26.6% |
| More than 10 year | 0 | 0% |

RBBB in 4 patient (26.6%), 1 with permanent pacemaker for postoperative complete heart block, see Table 6.

**Table 6. Shows ECG finding**

| ECG finding | No. of parient | % |
|---|---|---|
| Normal ECG | 11 | 73.3%% |
| RBBB | 4 | 26.6%% |
| AF | - | 0% |
| CHB | - | 0% |

*CHB:-complete heart block, AF:- Atrial fibrillation, RBBB Right bundle branch block*

### 4.4 Coarctation of the Aorta, Patent Ductus Arteriosus (PDA), Aortic Stenosis, Pulmonary Stenosis, Sever Mitral Valve Regurgitation Repair

15 patients, 9 were males (60%), 6 females (40%). No arrhythmia detected in these patients, see Table 7.

**Table 7. Shows the distribution :**

| | |
|---|---|
| Coarctation of the aorta | 6 |
| AS | 3 |
| PS | 2 |
| MR | 2 |
| PDA | 2 |

*Aortic stenosis: - (AS), pulmonary valve stenosis (PS), Mitral valve regurgitation (MR).Patent ductus arterosious (PDA)*

### 4.5 Tetralogy of Fallot

42 patients with repaired TOF, (59.5%) male, (40.4%) female, see Table 8.

**Table 8. Shows ECG finding**

| ECG finding | No. of parents | % |
|---|---|---|
| Normal ECG | 4 | 9.5% |
| RBBB | 37 | 88 % |
| LBBB | - | - |
| V. Ectopic | 1 | 2.5% |
| Sinus bradycardia | - | - |
| CHB | - | - |

### 4.6 Complex Congenital Heart Disease (CCHD)

25 patients, 14 male (56%), 11 female (44%), see Tables 9, 10, and 11.

**Table 9. Shows the distribution**

| | | |
|---|---|---|
| TGA | 6 | 24% |
| CCTGA with surgical closure of VSD | 1 | 4% |
| TAPVD | 2 | 8% |
| CCHD post Glenn | 7 | 28% |
| CCHD post Fontan | 3 | 12% |
| Ebstein's anomaly of TV | 3 | 12% |
| DIRV,PA | 2 | 8% |
| DIRV,Ps | 1 | 4% |

*Transposition of the great arteries (TGA),Congenitally corrected great artery (CCTGA) ,CCHD:- complex heart disease, tricuspid valve(TV), Double-Inlet Right ventricle (DIRV), pulmonary atresia (PA), pulmonary stenosis(PS)*

**Table 10. Shows time in year since operation**

| Time in year since operation | No. of patients | % |
|---|---|---|
| Less than 5 year | 12 | 48% |
| 5-10 year | 6 | 24% |
| More than 10 year | 7 | 28% |

## 5. DISCUSSION

In postoperative atrial septal defect (ASD), atrial tachyarrhythmia result from presence of atriotomy scar or patches.

In our study 2 patients (18.1%) with atrial fibrillation in ECG, and Holter monitor for complain of palpitation. None of our patients developed heart block or ventricular arrhythmia.

In study of J.W. Roos-Hesselink et al. [4] with one hundred and thirty-five patient with operated ASD. Supraventricular tachyarrhythmias present in (6%) after 15 years and an additional 2 occurred in the last decade, (5%) need pacemaker.

While in Cuypers JA. et al. [5] study, supraventricular tachyarrythemias were in 16% of patients, (6%) had pacemaker implantation. And in Constantine Mavroudis et al. [6] found 10% of patients with repaired ASD in childhood had AF.

**Table 11. Shows ECG finding**

| ECG finding | No. of parents | % |
|---|---|---|
| Normal ECG | 15 | 60% |
| RBBB | 4 | 16% |
| LBBB | 0 | 0% |
| SVT | 4 | 16% |
| Sinus bradycardia | 1 | 4% |
| CHB | 1 | 4% |

*CHB:-complete heart block, RBBB Right bundle branch block, LBBB:- left bundle branch block, SVT:- supraventricular tachycardia*

In post operative ventricular septal defect proximity to the AV node and ventricotomy scare there is risk of arrhythmia and heart block. In our study (60%) of patients had normal sinus rhythm, (12%) of patients develop permanent complete heart block and 28% with sinus rhythm with RBBB.

In Goris Bol Raap et al. [7] study, (26%) of the ECG showed a right bundle branch block, none had a complete A-V block, (4%) atrial fibrillation. And J.W. Roos-Hesselink et al [8] study, 88% had sinus rhythm, RBBB in 23% of patients, and CHB developed in 4% after 10 year postoperative. Myrthe E. Menting [9] showed that 13% of patient had late aahythemia including pacemaker implantation at 40 year.

In our study patients with postoperative repaired of AV Channel repair, (73.3%) of patients with normal sinus rhythm, (26.6%) of patients with RBBB, no patients developed CHB.

In study by Chauhan [10], permanent pacemaker implantation in 2.7% of patients. And in Rohit K. Kharband et al. [11] study, late post-operative SVTs were documented in (3.6%) of patient and 3.7% of the patients required pacemaker implantation and RBBB was reported in 26.7% of patents.

In TOF defect with a long standing right-ventricular pressure or volume overload with resulting fibrosis and dysfunction contributed to ventricular arrhythmia and etiology of RBBB after repair of TOF attributed to the injury of the proximal right bundle branch as in courses along the rim of VSD produced by repair of the VSD.

In our study RBBB in (97.3%) with repaired TOF, infrequent ventricular ectopic in 2.1% of patients.

In study of Maria Eulália Thebit Pfeifferel [12], bundle branch block (RBBB) was found in (89.0%), (8.1%) showed isolated ventricular premature beat. And in study of Konstandina Kuzevskael [13], forty six pediatric patients who underwent a complete repair of TOF right bundle branch block (RBBB) in all 46 (100%).

### 5.1 Complex Congenital Heart Disease (CCHD)

Fontan Operation is a final stage for patients with single ventricle physiology involves the creation of a pathway for inferior vena cava venous return to the pulmonary arteries, bypassing the right ventricle there is risk of arrhythmias include multiple RA reentrant circuits, focal atrial tachycardia. In our study here small number of children with fontan operation due to lake locally for this type of operation, three patients with fontan operation, one of them, a seventeen year old patient developed symptomatic bradycardia need pacemaker insertion, other case post fontan had atrial tachycardia in Holter monitor. 15 year operated child with DORV, pulmonary artesia developed postoperative CHB need pacemaker insertion.

In study of Jolien W. Roos-Hesselink [14], found in follow-up of patients with fontan operation, the incidence of supraventricular arrhythmias is even 56% during 17 years follow-up. While in Constantine Mavroudis [6] study found that those with fontan physiology, atrial arrhythmias develop in 13% to 60%.

In Epstein's Anomaly arrhythmia concerns associated with EA are right-sided accessory connections (15%–30%) of patients and dilation of right atrium increased risk of SVT. In our study we had three patients with Ebstein's anomaly of TV, had supraventricular tachycardia, two of them with WPW treated by ablation and the third one had atrial tachycardia.

In study of Antonio Herna´ndez-Madrid [15], (33%) of patients with Ebstein's anomaly had atrial tachyarrhythmias. In Paul Khairy [16] study, right-sided accessory pathways, classically associated with Ebstein's anomaly, and have been reported in 25%. The incidence of arrhythmia is highest in patient with complex congenial heart disease.

## 6. CONCLUSIONS AND RECOMMENDA-TIONS

Now children born with congenital heart diseases survive to adult life due to development in specialty of pediatric cardiology and cardiac surgery itself. Arrhythmias are one of the major issues in the follow-up of patients with congenital heart disease. A complete heart block developed up to 15 years post operative in patients after surgical closed of VSD for those lesions, those children need long term follow-up. More complex lesions require more frequent evaluation, medical treatment, and consideration for further surgical interventions.

Those symptomatic patients, we need more monitoring to patients with symptoms like transtelephonic electrocardiography and telemetry electrocardiographic monitoring and intracardiac electrophysiology testing which not available locally.

We need (ACHD) Adult Congenital Heart Disease clinic including both adult cardiovascular disease and pediatric cardiologist, along with an expert in CMR, interventional cardiology, electrophysiology, cardiac surgery to follow-up those patients in future.

## CONSENT AND ETHICAL APPROVAL

As per international standard or university standard guideline participant consent and ethical approval has been collected and preserved by the authors.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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