Postoperative complications in pediatric cardiac surgery patients done in a tertiary hospital

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Introduction
Postoperative complications can involve several organs and have a major effect on in-hospital stay length and quality of life of the children after discharge from the hospital. Although the complications are strictly related to the surgical procedure, postoperative pulmonary complications represent an important and probably underestimated cause of morbidity and mortality in postoperative pediatric heart surgery.

Aim
The aim of this study was to evaluate the relation between complication and the overall outcome.

Patients and methods
This retrospective descriptive study included 100 children (ages from 0 to 18 years old, excluding preterm babies) who underwent open heart surgery in Cardiothoracic Surgery Department of Assiut University in a 1-year period. The preoperative and intraoperative parameters included technique of operation, cardiopulmonary bypass time, and aortic cross-clamp time. The postoperative parameters included occurrence of postoperative complications, such as arrhythmias, heart failure, pulmonary congestion with chest infection, wound infection, and bleeding, and hospital stay of the patients.

Results
The occurrence of complications after congenital heart surgeries using cardiopulmonary bypass has significant relation with the cardiopulmonary bypass time; therefore, the longer the cardiopulmonary bypass time, the more the probability of cardiac and extracardiac complications. This study shows the same result as studies in adult surgery, demonstrating that complications after heart surgery significantly are associated with increased hospital stay time.

Conclusion
Surgery is the optimal and the final treatment for congenital heart diseases; nearly a quarter of the patients who undergo congenital heart surgery experience postoperative complications, complex congenital heart diseases with different degrees of heart failure, or respiratory failure, and carry more risk for complications. So close monitoring and timely intervention and treatment are very critical to avoid occurrence of multiple complications as reported in our study.

Keywords:
cardiopulmonary bypass, congenital heart surgery, tetralogy of Fallot, pediatric, postoperative complications

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Introduction

Congenital cardiopathy is the commonest congenital anomaly, estimated recently at 6–10 for each 1000 live births. A large number of these infants need surgery to correct or palliate their heart defect; many of them need surgery in the newborn period [1].

The development of heart-lung machine has been essential for the treatment of most congenital cardiopathies. There is a difference between using heart-lung machine in adults and in children, as a result of the issues of aortopulmonary shunts, the undeveloped cardiovascular system, and the circumstantial occurrence of deep hypothermic circulatory arrest.

The more prolonged the cardiopulmonary bypass time is, the more the hazardous effects on these factors, as cardiopulmonary bypass plays an overload role on the systemic circulation, which is almost compromised by prior heart failure.

Heart-lung machine, specific surgical technique, anesthesia, and different medications may result in production of multisystemic complications [2]. Postoperative care stresses mainly on expecting potentially hazardous effects and a timely intervention to revive cardiopulmonary homeostasis and to avoid end organ damage [3].

Postoperative period in children requires a much closer observation compared with adults because of the onset of continual changes regarding age, growth, maturation, development, preoperative state, and surgical technique. Newborns particularly because of the immaturity of primarily cardiovascular, respiratory, neurological, and renal systems may result in large numbers of complications that lead to increase in the morbidity and mortality.

Children who experience complex congenital heart diseases with different degrees of heart failure, respiratory failure, or shock are at a risk of multiple concomitant complications. Mortality rate in these patients is expected to be higher, as these patients require more complex surgeries. Nowadays, the mortality rate as reported by many centers is approximately 6% compared with 3% only in adult heart surgery.

Since the past years, congenital heart surgery has shown marked improvement and advancement. However, still postoperative complications either general or lesion-specific complications are to be expected early after surgery. The main role is to avoid low cardiac output and to prevent major organ affection. Acute low cardiac output, pulmonary hypertension, and diastolic dysfunction are examples of the most critical general complications, whereas valve dysfunction, residual shunts, or residual obstruction of ventricular outflow tracts, are likely to be anticipated after several congenital heart diseases and surgical techniques.

We aim to discuss the complications that occur after congenital heart surgeries and to evaluate the relation between these complications and the outcome measures.

Patients and methods

Study population

This is a retrospective descriptive study performed on 100 pediatric patients who underwent cardiac surgery in Assiut University Cardiothoracic Surgery Department who met the listed inclusion and exclusion criteria over a 1-year period. Ethics committee approval number 17100832.

Inclusion criteria

All pediatric patients indicated for cardiac surgery with/without usage of cardiopulmonary bypass (age ranging from 0 to 18 years old, excluding preterm babies) were included, except those mentioned in exclusion criteria.

Exclusion criteria

The following were the exclusion criteria:

(1) Heart and lung transplantations.
(2) Patients on mechanical ventilation before intervention.
(3) Patients with preoperative medical disorders other than cardiac affection.
(4) Redo patients.

The preoperative and intraoperative data included type of operation, cardiopulmonary bypass time, and aortic cross-clamp time.

The postoperative data included occurrence of postoperative complications such as arrhythmias, heart failure, pulmonary congestion with chest infection, wound infection, and bleeding, as well as hospital stay of the patients.

Patient characteristics recorded were as follows:

(1) Age (years).
(2) Sex.
(3) Weight (kg).
(4) Laboratory data.

Preoperative and postoperative variables recorded were as follows:

(1) Echocardiography.
(2) ECG.
(3) Pulmonary artery systolic pressure.
(4) Laboratory data.
(5) Heart rate (bpm).
(6) Temperature.

Results

Of the 100 patients, VSD-closure is the commonest procedure (34%) followed by TOF-correction (19%), as shown in Table 1.

Of these patients, only 20% had preoperative pulmonary hypertension, as shown in Fig. 1.

Average cardiopulmonary total bypass time (TBT) and average ischemic time (IT) were 102.73 ± 23.00 and 71.82 ± 17.64 min, respectively, as shown in Table 2.

Of the five studied complications, chest infection is the commonest (10%) followed by heart failure (8%), and wound infection and pulmonary hypertension (7% each), as shown in Fig. 2.

Mortality accounted for 7% in our study, as shown in Table 3. Moreover, the study showed that there is a significant relation between cardiopulmonary TBT

Table 1 Surgical procedure

Diagnosis	*n*=100 [*n* (%)]
VSD	34 (34.0)
Fallot	19 (19.0)
ASD	16 (16.0)
PDA	10 (10.0)
Subaortic membrane	9 (9.0)
MR	8 (8.0)
PS	7 (7.0)
CoA	2 (2.0)
Others	5 (5.0)

ASD, atrial septal defect; CoA, coarctation of aorta; MR, mitral regurge; PDA, patent ductus arteriosis; PS, pulmonary stenosis; VSD, ventriclar septal defect.

Table 2 Cardiopulmonary bypass

	Mean±SD	Range
TBT (min)	102.73±23.00	45.0-180.0
IT (min)	71.82±17.64	30.0-100.0

IT, ischemic time; TBT, total bypass time.

Table 3 Outcome

	%
Hospital stay (days)	
1-7	40.0
8-10	33.0
>10	27.0
Mean±SD (range)	11.71±9.69 (1.0-60.0)
Outcome	
Alive	93.0
Dead	7.0

and IT and outcome (hospital stay, complications, and mortality rate), as shown in Tables 4 and 5, respectively. The study also showed a significant relation between complexity of procedure and outcome (complications and mortality rate increased in patients with tetralogy of Fallot), as shown in Table 6.

Discussion

Surgery is the optimal and the real final treatment for pediatric congenital heart diseases, and as any other invasive procedure, it is associated with several complications. So after open heart surgery, close monitoring and timely intervention and treatment are very critical to avoid occurrence of multiple complications as reported in our study.

Although there are no comprehensive studies of complication diagnoses during pediatric open heart surgery admissions, certain types of complications have been examined in different studies. Such as, studies examining nosocomial infections have reported that approximately 22% of patients underwent pediatric heart surgery acquired at least one nosocomial infection [4–6]. During stay in the postoperative intensive care unit, 18% of the patients experienced an arrhythmia owing to medical or surgical causes [7]. Other complications that occurred after pediatric heart surgery have been reported as follows: hepatic complication (9%) [8], cardiac tamponade (7%) [9], and diaphragmatic paralysis (5.4%) [10]. Many cases of isolated complications are also reported [11–14].

This study shows the same result as other studies in adult cardiac surgery which show that complications after heart surgery are significantly associated with increased hospital stay time [15,16]. Moreover, they

Table 4 Relation between total bypass time and outcome

	TBT (min)		*P*
	Mean±SD	Median (range)	
Hospital stay (days)			0.050*
1-7	95.03±24.15	95.0 (45.0-150.0)	
8-10	103.30±17.68	100.0 (60.0-130.0)	
>10	111.52±25.23	110.0 (80.0-180.0)	
Complications			0.010*
Yes	115.75±29.00	116.5 (60.0-180.0)	
No	97.92±18.39	100.0 (45.0-130.0)	
Outcome			0.003*
Alive	99.91±20.40	100.0 (45.0-180.0)	
Dead	135.71±27.60	150.0 (80.0-160.0)	

TBT, total bypass time. *Significant correlation between Total Bypass Time

Table 5 Relation between ischemic time and outcome

	IT (min)		*P*
	Mean±SD	Median (range)	
Hospital stay (days)			0.149
1-7	67.45±17.86	68.0 (30.0-100.0)	
8-10	72.45±18.50	80.0 (30.0-94.0)	
>10	76.40±15.45	80.0 (45.0-100.0)	
Complications			0.057
Yes	77.71±18.71	80.0 (40.0-100.0)	
No	69.65±16.86	71.0 (30.0-94.0)	
Outcome			0.011*
Alive	70.51±17.09	70.5 (30.0-100.0)	
Dead	87.14±17.99	90.0 (50.0-100.0)	

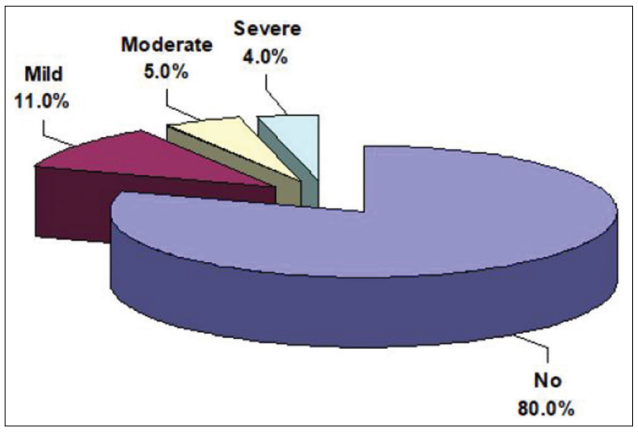
IT, ischemic time. *significant correlation between Ischemic Time and Hospital Outcome

Table 6 Outcome according to tetralogy of Fallot

	Fallot [*n* (%)]		*P*
	Yes	No	
Hospital stay (days)			0.057
1-7	3 (15.8)	37 (45.7)	
8-10	9 (47.4)	24 (29.6)	
>10	7 (36.8)	20 (24.7)	
Complications			0.075
Yes	8 (42.1)	18 (22.2)	
No	11 (57.9)	63 (77.8)	
Outcome			0.002*
Alive	14 (73.7)	79 (97.5)	
Dead	5 (26.3)	2 (2.5)	

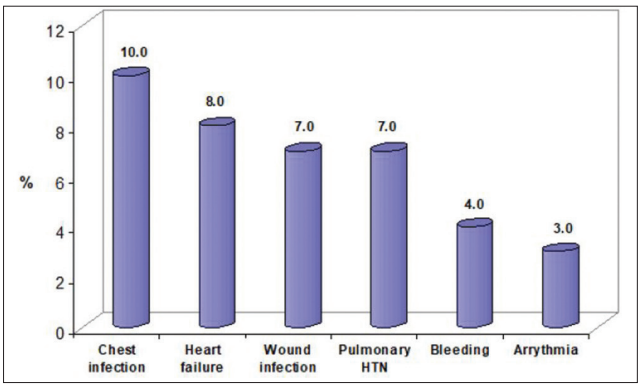
*significant correlation between Hospital Outcome and tetralogy of Fallot patients.

Figure 1



Percentage of preoperative pulmonary hypertension.

Figure 2



Percentage of the studied complications.

show the significant relation between postoperative complications and mortality rate as an agreement with the results from different studies [17,18].

In addition, there are many limitations in our study. It shows postoperative complications among 100 patients, with age range from 0 to 18 years. Overall, 35% of the patients were aged less than 3 years old, 31% aged from 3 to 6 years old and 31% aged more than 6 years old. It also shows that 51% of the patients were males and 49% were females. Our study found that VSD was the commonest case diagnosis operated in our center in 34%, followed by TOF in 19% then ASD in 16%, PDA in 10%, subaortic membrane in 9%, mitral regurge in 8%, pulmonary stenosis in 7%, CoA in 2%, and others (including partial and complete A-V canal and single ventricle) in 5%. Of all of these cases, 80% have no pulmonary hypertension and 20% have pulmonary hypertension of different grades (mild 11%, moderate 5%, and severe 4%).

In our study, we only studied five postoperative complications, which are arrhythmia, bleeding, sepsis including chest and wound infection, pulmonary hypertension, and heart failure. We observed that chest infection is the commonest complication, accounting for 10% of all patients, followed by heart failure (8%), wound infection (7%), pulmonary hypertension (7%), postoperative bleeding (4%), and arrhythmia (3%).

Mortality accounted for 7% in our study. Moreover, the study showed that there is a significant relation between cardiopulmonary TBT and IT and outcome (hospital stay, complications, and mortality rate), in which the longer the cardiopulmonary bypass time, the more probability of cardiac and extracardiac complications. The study also showed a significant relation between complexity of procedure and outcome (complications and mortality rate increased in patients with tetralogy of Fallot).

Comparison of the present study with a previous study conducted in Assiut University Hospital by Ghoneim *et al.*[19] shows that postoperative mortality rate was 5.6%. It also shows that postoperative complications account for 54.5% compared with 23% in our study, as they encountered all types of postoperative complications not only the five complications discussed by us. It also shows that postoperative serious arrhythmia is the commonest complication (28%) followed by postoperative fever and chest infections (12%). Both studies agreed that we must increase our experience in the management of congenital heart patients and in the postoperative ICU intervention strategies.

Conclusion

Nearly a quarter of the patients who underwent congenital heart surgery experienced postoperative complications, and it is reflected on the pediatric cardiac ICU and hospital stay and increasing mortality rate.

Cardiac surgery is at high risk for postoperative complications, involving the heart itself or other organs, most importantly kidneys, lungs, and brain. Efforts should be made to identify preoperatively patients at high risk for the development of complications, and more studies are warranted to clarify the role of the determinants of these complications, including type of anesthesia, mechanical ventilation, and postoperative management of vasoactive drugs.

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Conflicts of interest
There are no conflicts of interest.

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