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RESEARCH ARTICLE

DOES CARDIAC TROPONIN–I IS RECOGNIZED AS AN EARLY POSTOPERATIVE MARKER FOR MYOCARDIAL DAMAGE IN CHILDREN?

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Abstract

Introduction: Cardiac troponin-I being a sensitive marker of myocardial damage needs to be analyzed in children undergoing cardiopulmonary by-pass surgery, as perioperative myocardial damage may be a significant factor of postoperative cardiac performance. The present study aims to test the prognostic value of Cardiac troponin-I concerning the early postoperative course after pediatric cardiac surgery.

Methods: Cardiac troponin – I levels were measured and correlated with intra and postoperative parameters of thirty-three children undergoing open-heart surgery. The cutoff point for the definition of a high and a low-risk group of Cardiac troponin-I values was set at 25 ng/ml.

Results: Overall, cTnI peak value was higher than 25 ng/ml in 21 patients; among these,4 died, and two of them were reported with the value of >100 ng/ml. 38.7% of the patients were complicated by different types of arrhythmias. Junctional ectopic tachycardia was the most common type of arrhythmia,while heart block complication was found only in one case, which was temporarily treated by pacing for less than 24 hours. The results showed significant correlation of troponin I values with dobutamine dose mg/kg (p-value=0.043), dobutamine duration (p-value=0.020), creatinine (p-value= 0.002), and internalcare unit stay (p-value= 0.003).

Conclusion: The present study confirms that troponin I is specific and sensitive marker of myocardial injury after pediatric cardiac surgery.

Introduction:-

The structure and function of heart is reflected by the cardiac biomarkers, which are broadly used to manage heart failure and myocardial injury in adult patients. Likewise, their use in pediatrics, specifically in neonatology, has been emerging, rapidly. However, their clinical role is not apparently established and no guidelines are present to guide their routine use for diagnosis, prognosis, and treatment.[1] Creatine kinase myocardial band (CK-MB) and cardiac troponins (cTnT and cTnI) are the recommended myocardial damage indicators. cTnT and cTnI are myocardial antigens; whereas, CK-MB is an essential indicator of myocardial necrosis. Cardiac troponins are particular indicators for myocardial injury since they are released at the time of minimal myocardial damages and

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can stay longer in the plasma. Therefore, plasma cTn levels are particularly beneficial in the diagnosis of perioperative myocardial damages to assess operational outcome.[2]

Cardiac troponin-I (cTnI) is a particular marker of myocardial damage, in the young population, and its increased levels predict short-mid and long-term mortality after cardiac surgery.[3]cTnI has been considered as a particular marker of myocardial damage from ischemia/reperfusion injury and direct trauma in pediatric patients. The efficacy of cTnI has been observed in reporting the 30-day mortality and the mid-term changes.[4] On the contrary, evidence of cTnI efficacy is scarce for predicting the midterm outcome. The short-term outcome is revealed after 30 days of surgery; although, no apparent definition is present regarding the timing of the consequence.[5] Determining the value of cTnI to predict all-cause mortality up to 3 months after pediatric cardiac surgery is the primary endpoint. Intra-hospital and 6 months mortality and morbidity, and the length of hospital stay and in the pediatric intensive care unit are the secondary outcomes.[3] Therefore, this study mainly aims to assess prospectively whether the postoperative cTnI level serves as an independent predictor of mortality rate in infants undergoing open-heart surgery. The secondary aim was to assess whether postoperative cTnI levels might predict early clinical outcomes in these infants.

Methods:-

Setting and Participants

This cohort study was conducted at the postoperative internal care unit (ICU) from December 2017 to March 2020. Thirty-three infants undergoing open-heart surgery were included in this study. The inclusion of these infants was based on the following parameters: (1) age of 2 months up to 12 years; (2) both male and females; and (3) patients undergoing an elective operation for ventricular septal defect (VSD), atrioventricular (AV) defect or Tetralogy of Fallot. Participants with high level of cTnI measured preoperatively and major intraoperative events such as fatal or arrest arrhythmias were excluded.

Ethical Consideration

The project obtained the approval from hospital Institutional Review Board.

DataCollection

Setting and Participants

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Data Analysis

The data collected were revised for accuracy and entered into a Microsoft Excel program. Afterward, the data were transferred into the Statistical Package for Social Sciences (SPSS) program version 20.0. Data were presented statistically in terms of mean, standard deviation, frequencies, and percentages. Mann Whitney U test for independent samples was used for the comparison of numerical variables. A chi-square test was performed to assess the correlation between troponin-I and postoperative cardiac damage for children. Accuracy of results was stated in terms of specificity and sensitivity. Receiver operator characteristic (ROC) analysis was used for determining the optimum cut off value for the studied diagnostic markers. The results were considered statistically significant at p-value = 0.05.

Results:-

The demographic profile for the patients is shown in Table 1. It shows that 58.1% were male patients and 41.9% were female patients, who underwent open-heart surgery. Othe details regarding age and cardiac lesions have also been presented in table 1.

Table 1: Demographic Profile

Sex	Frequency	Percent
Female	13	41.9
Male	18	58.1
Total	31	100.0
Age	**Frequency**	**Percent**
< 12 months	9	29.0
12 months or more	22	71.0
Total	31	100.0
Cardiac lesions	**Frequency**	**Percent**
ASD	1	3.2
Fallot tetralogy	11	35.5
VSD	15	48.38
CAVC	4	12.9
Total	31	100.0

Table 2 shows descriptive statistics for the duration and incidence of re-intubation. It represents that 61.3% of the patients were given mechanical ventilation for 12 hours; while, 22.7% of the patients were given >12 hours of mechanical ventilation. Only 6.5% of the patients were reported with re-intubation; while, 93.5% of the patients had no re-intubation.

Table 2: Duration and Incidence of Re-Intubation

Mechanical ventilation duration	Frequency	Percent
12 hours	19	61.3
>12 hours	12	33.7
Total	31	100
Re-intubation incidence	**Frequency**	**Percent**
No	29	93.5
Yes	2	6.5
Total	31	100

Table 3 shows the general characteristics of arrhythmias in patients and states that 61.3% of the patients showed no incidence of arrhythmias. Moreover, 38.7% of the patients showed an incidence of arrhythmias with 50% having junction ectopic tachycardia type of arrhythmia. The right bundle branch block was the second major type of arrhythmia (25%).

Table 3: General Characteristics of Arrhythmias

Incidence	Frequency	Percent
No	19	61.3
Yes	12	38.7
Total	31	100.0
Type of arrhythmia	**Frequency**	**Percent**
Heart block	1	8.3
Junction ectopic tachycardia (JET)	6	50
Jet then ventricular tachycardia (VT)	1	8.3
right bundle branch block (RBBB)	3	25
Pulseless electrical activity (PEA)	1	8.3
Total	12	100

Table 4 shows that 90.3% of the patients reported no post-operative complications; whereas, only 9.7% of the patients reported an incident of postoperative complications. The presence of phrenic nerve injury, peritoneal dialysis, and readmission was reported equally among patients (33.3%).

Table 4: Characteristics of Post-Operative Complications

Incidence	Frequency	Percent
No	28	90.3
Yes	3	9.7
Total	31	100.0
Type	**Frequency**	**Percent**
Phrenic nerve injury	1	33.3
Peritoneal dialysis	1	33.3
readmission	1	33.3
Total	3	100

The relationship between different postoperative outcomes in accordance with the cutoff Points of Troponin-I Values in table 5. The findings have shown a positive and significant relationship of troponin I values with dobutamine dose mg/kg (p-value=0.043), dobutamine duration (p-value=0.020), creatinine (p-value= 0.002), and ICU stay (p-value= 0.003).

Table 5: Relationship between different postoperative outcomes in accordance with the cutoff Points of Troponin-I Values

	Group A	Group B	P value
	cTn-I less than 25	cTn-I more than 25	
NO.	10	21	
Age (months)	16 (18.6)	14(17.7)	0.471
Acc (minutes)	45(47)	50(51)	0.576
Cbp(minutes)	60(57.5)	70(74.2)	0.056
FS%	34.5(34.3)	33(32)	0.053
Dobutamine dose	20.5(18.5)	31.5(44.78)	0.043
Dobutamine duration	23(26.8)	37.5(56.5)	0.020
Adrenaline dose	0.240(0.183)	0.236(0.370)	0.553
Adrenaline duration	40.00(33.33)	47.50(48.70)	0.310
Milrinone dose	0	1.800(2.911)	
Milrinone duration	0	42.00(74.29)	
MV >12h	2	8	0.234
creatinine	0.40(0.40)	0.60(0.65)	0.002
A.S.T	47.50(47.20)	55.00(74.79)	0.136
A.L.T	53.00(55.80)	55.00(64.32)	0.963
I.C.U stay	3.00(3.60)	6.00(5.84)	0.003
Hospital stay	6.00(5.40)	6.00(7.37)	0.083

Figure 1presents the ROC curve for cTnI to predict arrhythmias, showing a 90% sensitivity and 31.6% specificity. The ROC curve was reported to be 37.5 ng/dl. Similarly, 80% sensitivity and 10% specificity were reported for CPB in predicting arrhythmias with a ROC curve value of 62.5 ng/dl (Figure 2).

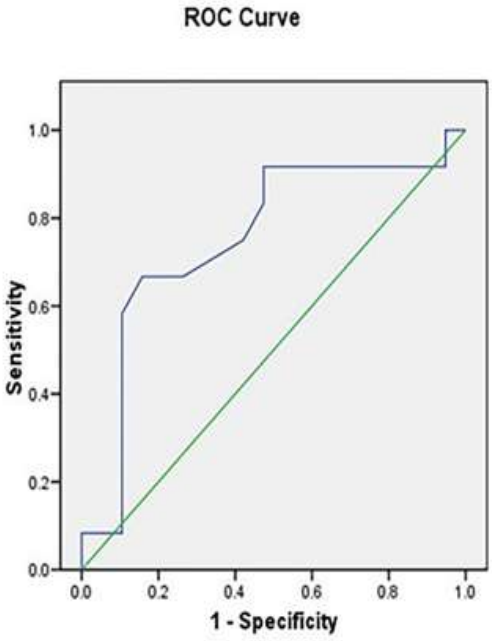

Fig. 1

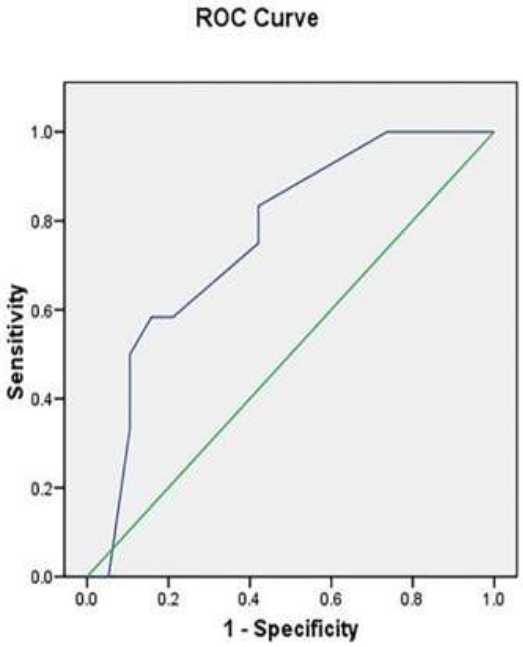

Fig.2

Figure 1: ROC Curve for cTn I in predicting arrhythmias

Figure 2: ROC Curve for CPB in predicting arrhythmias

Discussion:-

Arrhythmias still remain a fearsome complication after congenital cardiac surgery despite enhancements in surgical techniques such as perioperative management and perfusion technology. The present study shows that 38.7% of the patients were complicated by different types of arrhythmias. Junctional ectopic tachycardia (JET) was the most common type of arrhythmia; while, heart block complication was found only in a single case. The study has also found a significant correlation between the level of cTnI and CPB time to the incidence of arrhythmia.

Previous studies have shown that the 48% chance of occurrence of postoperative arrhythmias in children. [6-8] The comparatively high occurrence in some reports might be associated with the difference in study definitions for arrhythmia inclusion in the analysis. Benign variations in rate and rhythm are also included along with ventricular and premature atrial complexes.

In the present study, JET was the commonest arrhythmia detected that is supported by Sahu et al.[9] Sahu et al.[9] reported association between JET and VSD closure with the complete repair of other defects such as Tetralogy of Fallot (TOF), atrioventricular septal defect (AVSD), and Transposition of the great arteries (TGA), either in isolation or in combination. The study has used the ROC curve for getting the lowest cut-off point for predicting the incidence of arrhythmia and it was 25.4ng/ml for cTnI and 62 minutes for CPB time. This study has also found that the ROC curve of the cTnI level was higher as compared to the ROC curve of CPB time. Therefore, the cut-off point of cTnI is more accurate statistically to predict arrhythmia as compared to the cut-off point of CPB time.

The cutoff point of cTnI level was set at 25 ng/ml for the definition of high (more than 25 ng/ml) and a low (less than 25 ng/ml) risk group. Statistically significant outcomes were obtained for the doses of vasoactive support (but not for adrenaline dose), duration of vasoactive support, serum values of creatinine (but not for hepatic function), and ICU admission period but not for hospital admission period. These findings are supported by Immer et al.,[10] where they found that the cTnI level was statistically significant with clinical outcomes. Immer et al.[10] has supported the findings of the present study by obtaining statistically significant association for the duration of vasoactive support, doses of vasoactive support, duration of intubation, serum values of hepatic function and creatinine.

Two of the patients, in this study, died in the initial 6 hours following the operation. These findings are supported by Su et al.[11] and Güzelmeriç,[12] where they found lethal cTnI of 100ng/ml. Neves et al.[13] found that the clinical outcome was not associated with the duration of CPB. Immer et al[10] have set the cut-off point of CPB to be at 100 minutes without explaining that from a statistical point of view. Also, the statistically significant outcome was reached for cTnI values at 4 hours as well as the doses of vasoactive support, serum values of creatinine, hepatic function, and duration of intubation.

The findings of present study indicated that patients with arrhythmias might have had a myocardial injury throughout surgery because of several procedural-associated causes in the early postoperative period. The myocardial injury might be part of the systemic inflammatory response to CPB, ischemia-reperfusion injury, release of histamine, and altered myocardial membrane potential. The main limitation of this study is the small sample size and increasing the number of patients is likely to change the results. There is a wide range of inotropic dose which made a huge difference in the mean total dose of inotropic support for this study. Therefore, future studies need to consider a larger sample size with inclusion of control group to provide more authenticity in predicting factor for early in-hospital outcome.

Conclusion:-

Postoperative complications associated with the degree of perioperative injury include an increase in the duration of mechanical ventilation, an increased need for inotropic support and a decrease in urine output, all of which contribute to an increase in the length of ICU stay. Levels of cTnI allow a reproducible prediction of severe postoperative complications and of the duration and the extent of intensive care treatment. Perioperative measurement of cTnI identifies children within specific cardiac defect subgroups at risk of mortality after cardiac surgery. This study has speculated that the detection of myocardial injury may decrease mortality and morbidity in children with complicated congenital cardiac lesions by leading to improvements in perioperative management.

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