

## Evaluation of liver function tests after coronary artery bypass surgery (CABG)

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### Abstract

**Background:** Coronary artery bypass graft surgery (CABG) may have systemic effects on the body organs as liver. The purpose of present study was to evaluate changes in liver function tests(LFT) after on-pump CABG surgery and risk factors associated with LFT changes.Also, the incidence of acute liver injury after on-pump CABG is determined.

**Methods:** 385 patients who underwent on-pump CABG surgery were randomly selected.Preoperative and intraoperative risk factors were obtained from their medical records .Postoperative liver function tests at 24, 48 and 72 hours following surgery and discharge time were compared with the preoperative ones. A univariate linear regression analysis was used to assess the possible relationships between these changes and the preoperative and intraoperative risk factors.

**Results:** Statistical analysis revealed direct and significant relationship between LFT changes and pump time, aortic cross-clamp clamp time and use of intra-aortic balloon pump(IABP). Also a medical history of previous myocardia infarction was significantly related to the changes in direct bilirubin in the first 48 hours following surgery.level of preoperative left ventricle ejection fraction,smoking and using opium had significant correlation with postoperative AST changes in different days.In 12.9% of patients, the aminotransferases levels increased to more than three folds over normal upper limit but the probability for incidence of acute ischemic liver injury (transient increase in aminotransferases to over 500IU/L) was 0.77%.

**Conclusion:** Using techniques to reduce clamp and pump time when possible is important during CABG. Probable liver injuries post inserting IABP should be expected for appropriate monitoring and treatment.

**Keywords:** Coronary artery bypass graft surgery, Liver function tests, Pump time, Clamp time,Ischemic liver injury

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Considering the growing prevalence of coronary artery diseases, the coronary artery bypass graft surgeries are increasingly growing (1, 2). Therefore, assessment of complications involved in such operations as well as their associated risk factors are of the utmost importance toward improving the patient survival rates.Acute liver ischemic injury is a rare complication of on-pump CABG surgery but is associated with significant morbidity and mortality (3).The classic CABG surgery method is performed using cardiopulmonary bypass (CPB). In this kind of surgery, patients are often at the risk of organ disorders due to cardiac arrest and the impaired systemic blood flow.The hypoperfusion occurring during CPB has been reported as the underlying reason behind such complications (4).

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Many studies have indicated the role of hypoperfusion, free radical formation, oxidative stress and the upregulation of catecholamines release during CPB procedure in complications and organ dysfunction following cardiac surgery (5, 6). Most of the previous studies have focused on neurologic, pulmonary and renal complications, while the post-CABG gastrointestinal side effects have been less considered.

In spite of the fact that the gastrointestinal complications after cardiac surgery are uncommon (%0.41-3.7), their associated mortality rate is high (%13.9-52) (3, 4). Among gastrointestinal side effects, liver complications are particularly important. It is reported that nearly 10% of patients undergoing high-risk CABG with CPB, experience some degrees of liver injury leading to the liver failure in some cases(7). That shall be expected to affect patient's recovery or increase mortality rates (7). Although some previous studies have evaluated the pattern of changes in liver biochemical tests and relating factors, thus the results are different (4, 8-11).

Despite all the advances made in surgery methods and surgical reperfusion technologies, gastrointestinal complications and the consequent mortality rates hardly endured a diminishing trend during the past two decades and remained a serious clinical problem.

The best way to reduce the mortality rate caused by such complications is an early diagnosis and rapid invasive treatments (3). Therefore, one of the future strategies for reducing morbidity and mortality is to predict the likelihood of ischemic liver injury in the patients after different types of open-heart surgery (12).

The purpose of the present study was to evaluate changes in liver function tests and incidence of acute liver injury after on-pump CABG surgery.

Acute liver injury was defined as an acute increase in serum alanine amino transferase (ALT) levels to more than 500 IU/L within 48 hours of surgery in the absence of other possible causes (12).

Furthermore, this research aims at determining the relationship between liver dysfunction and some risk factors such as age, gender, BMI, diabetes mellitus, hypertension, hyperlipidemia, previous myocardial infarction, cigarette and opium smoking, preoperation cardiac ejection fraction, duration of pump time and cross-clamp time, and using inotropic agents and intra-aortic balloon pump during the surgery.

## Methods

This is a retrospective cross-sectional study of the patients who have undergone on-pump CABG surgery by one of the cardiothoracic surgeons of Rouhani Hospital in Babol during 2012 to 2016. In this analysis, 520 patients were randomly chosen out of our statistical population, consisting of 1343 patients. The analysis was performed based on a descriptive analytical method using the intended data collected from their medical records. The data regarding patient's age, gender, height, weight, and past medical history including diabetes mellitus, hypertension, hyperlipidemia, history of myocardial infarction, any hepatic, biliary or hematologic disorders and using cigarette and opium were obtained from their medical records.

Other necessary information, such as surgery techniques, inducing anesthesia, drugs and patient's condition during surgery, was extracted from their surgical summary and anesthetic records. The patients who had undergone emergent CABG surgery or simultaneous CABG surgery along with valve plasty were exempted from the study.

Surgical and anesthetic techniques were similar in all patients. General anesthesia was induced by intravenous thiopental and atracurium. Fentanyl, atracurium and midazolam were used for anesthesia maintenance. After anesthesia, a median sternotomy was performed, followed by routine aortic and atrial cannulation. CPB was established with a flow of 2.4-2.6 lit/min/m<sup>2</sup> using membrane oxygenation, non-pulsatile perfusion. Body temperature was reduced to 30-32°C in all patients (mild hypothermia). Mean arterial pressure was kept over 70 mmHg. Inotropic drugs (epinephrine, norepinephrine or dopamine) were used in case of any drop from this level. In some cases, intra-aortic balloon pump was inserted to handle pressure drops.

According to the laboratory data, the liver function parameters including ALT, AST, ALP, total and direct bilirubin level for the preoperative day and at 24, 48, 72 hours after the surgery as well as those at discharge time were obtained from the medical records. In this step, patients with incomplete laboratory data, abnormal liver function tests or known hepatobiliary disease before the surgery were excluded from the analysis. Hepatitis viral markers were also checked in all patients, and positive ones were excluded from the study. Finally, 385 patients who fulfilled the entire inclusion criteria, entered the study. The required sample size was calculated based on Cochran's formula. Also SPSS software was used for the statistical analysis of the patients'

data. The univariate linear regression model with cross-sectional data was used to assess the effect of intended factors (independent variables) on the incidence of liver injury (Eq(1)).

$$Y_i = \alpha + \beta X_i + \varepsilon_i \quad \text{Equation (1)}$$

The independent variables were indicated by any increase in LFT parameters compared to the preoperative levels ( $\Delta$ ).

The independent variables were considered as age, gender, some factors of past medical history, pump time and cross clamp time, blood pressure drops and use of inotropic drugs and intra-aortic balloon pump.

The level and direction of the independent variables' effect on the dependent ones have been demonstrated by the regression model. Microsoft office excel and SPSS software were used for descriptive analysis of the data and the regression model estimation, respectively.

## Results

The analysis was carried out on the population of 385 qualified patients who gained the inclusion criteria including 48.6% females and 51.4% males ranging from 35 to 85 years old, mainly between 56 to 65. 31.4% of the samples had a history of previous myocardial infarction, 40.3% were diabetic, 33.5% had hyperlipidemia and 59.5% had hypertension. 11.6% of patients were smokers or opium addicts. Body mass index was in the normal range for 38.7% of the patients and above the normal range for 59.7% (table 1).

The average cardiac ejection fraction was in the range of 50-75%. The mean duration of the pump time was 100.20±32.45 minutes and for the clamp time was 56.11±18.60 minutes. Inotropic drugs were used for 50.9% and intra-aortic balloon pump was inserted in % 1.3 of patients (table 2).

In this study, ischemic liver injury (transient increase in aminotransferases to over 500 IU/L during first three days following surgery) occurred in 3 patients (0.77%), one of them died. The total in hospital mortality was 1.3%. As regards the changes in LFT parameters, the average value of pre-operative AST level (22.05±6.5 IU/L) increased up to 159% and reached to its maximum in second postoperative day (57.28 IU/L).

The mean of pre-operative ALT in all patients (19.5±6.99 IU/L) increased up to 69% and reached to maximum in third

post-operative day (32.98 IU/L). The mean of the patients' pre-operative ALP levels (189.27±73.9 IU/L) decreased during the first three days after surgery and returned to 190 IU/L at the discharge time.

The mean of pre-operative total bilirubin level (0.80±0.42 mg/dL) reached to maximum in the second post-operative day (1.07 mg/dL) by growing up to 33.75%, and mean of the direct bilirubin levels increased up to 39.13% and peaked in second postoperative day (0.32 mg/dL) (table 3).

**Table 1. Base line patient characteristics**

Variable	Frequency	Percentage	
Sex	male	187	48.6
	female	198	51.4
Age	35-45	23	5.97
	46-55	73	18.96
	56-65	150	38.96
	66-75	111	28.83
	76-85	28	7.28
	<18.5	6	1.57
BMI	18.5-24.9	149	38.7
	25-29.9	152	39.48
	≥30	78	20.25
Previous infarction	myocardial	121	31.4
Diabetes mellitus		155	40.3
Hyperlipidemia		129	33.5
Hypertension		229	59.50
Using cigarette and opium		43	11.16

**Table 2. Frequency distribution of factors related to the surgical condition**

variable	frequency	percent
Use of inotrope drugs	196	50.9
Insertion of intra-aortic balloon pump	50	1.3
Pump Time (mean±SD)	100.20±32.45	
Clamp Time(mean±SD)	56.11±18.60	

**Table 3 .Mean standard deviation and median of liver function tests parameters in different times**

Time LFT	Preoperative	First Postoperative day	Second Postoperative day	Third Postoperative day	Discharge Time
AST	22.05±6.47 (21)	43.11±42.46 (36)	57.28±84.01 (40)	56.70±175.82 (32)	31.54±42.26 (26)
ALT	19.50±6.98 (18)	24.54±33.03 (20)	30.07±67.68 (20)	32.97±108.28 (18)	22.49±27.87 (17)
ALP	189.26±73.89 (178)	154.66±72.53 (140)	159.67±79.88 (145)	170.95±94.03 (154)	189.99±132.46 (163)
Bil T	0.79±0.41 (0.70)	1.02±0.57 (0.90)	1.07±0.77 (0.90)	0.90±0.53 (0.80)	0.88±0.77 (0.80)
Bil D	0.22±0.17 (0.20)	0.28±0.19 (0.20)	0.31±0.29 (0.26)	0.27±0.19 (0.20)	0.27±0.36 (0.20)

AST;aspartate aminotransferase, ALT;alanine aminotransferase, ALP; alkaline phosphatase,BilT; total bilirubin,Bil D;direct bilirubin

The method used to determine the cause-and-effect relationship between dependent (LFT parameters) and independent variables was regression analysis. To avoid the effects of autocorrelation between the independent variables, impact of each variable on the LFT parameters was evaluated separately using univariate linear regression model. The relationship considered significant at 95% confidence level, if  $|t| \geq 2$  or  $\text{sig} \leq 0.05$ . The following items are the results of the regression analyses reported in 3 parts:

**1. Evaluating effects of the independent variables related to the surgery condition on LFT changes:** The four analyzed independent variables related to the surgery conditions were the pump time, the clamp time, use of inotropic drugs and insertion of intra-aortic balloon pump. Results of the regression analysis for the effects of these variables on LFT parameters are represented in table 4. There was a direct and significant correlation between the pump time duration and AST level changes in the first and second postoperative days ( $\Delta\text{AST1}$  and  $\Delta\text{AST2}$ ) and also direct bilirubin changes in the third postoperative day ( $\Delta\text{BilD3}$ ) compared to pre-operative levels.

Clamp time duration had a direct and significant correlation with the AST level changes in the first and second postoperative days, ALT level changes in second postoperative day and total bilirubin changes in the first postoperative day. The use of inotropic drugs followed by blood pressure drop during the surgery indicated a direct and significant relationship with AST level changes in the first postoperative day. There was a direct and significant correlation between using intra-aortic balloon pump during the surgery and the changes in all LFT parameters

(aminotransferases in first three postoperative days, ALP in the first postoperative day, total and direct bilirubin in the third postoperative day and the discharge time).

**2. Evaluation of the effects of independent variables related to patients' individual characteristics on the LFT variations:** Three independent variables are related to the patients' personal characteristics including age, gender, and BMI. According to the results of regression analysis, there is a direct and significant correlation between age and changes in AST levels in discharge time from pre-operative levels ( $t: 2.894$ ,  $\text{sig}: 0.004$ ). In addition, there was a reverse significant correlation between age and ALP level changes in the third postoperative day ( $t: -2.061$ ,  $\text{sig}: 0.040$ ). Male gender indicated a direct and significant correlation with the ALP level changes in the first postoperative day ( $t: 2.097$ ,  $\text{sig}: 0.037$ ) and had a reverse significant correlation with total bilirubin changes in discharge time from pre-operative levels ( $t: -2.503$ ,  $\text{sig}: 0.013$ ). BMI had a significant negative correlation with total bilirubin changes in the second postoperative day from pre-operative levels ( $t: -2.041$ ,  $\text{sig}: 0.042$ ).

**3. Evaluation of the effects of independent variables related to the patients' background records of the underlying diseases on LFT changes:** In this part, HTN, HLP, DM, EF (heart failure) and addiction to cigarette and opium are selected as independent variables. According to the regression analysis results, except for the history of previous MI, which had a direct and significant correlation with total bilirubin level changes in the first 48 hours of the following surgery ( $t: -2.704$ ,  $\text{sig}: 0.005$ ), other cardiovascular risk factors in this study (HTN, HLP, and DM) demonstrated no significant relationship with the dependent variables.

Underlying heart failure is expressed by the low cardiac ejection fraction. There was a significant negative correlation between the EF levels and AST changes in the first postoperative day (t: -2.5, sig: 0.00), total bilirubin level changes in the second and third postoperative days (t: -3.090, sig: 0.002 and t: -3.264, sig: 0.001) and also direct bilirubin level changes in the third postoperative day (t: -2, sig: 0.04).

Regarding the cigarette and opium smoking history, there was a direct and significant correlation between smoking and the changes in AST levels in the second and third postoperative days and along with changes in direct bilirubin levels in the third postoperative day. There was also a direct and significant correlation between using opium and changes in AST levels in the third postoperative day (t > 2, sig < 0.03).

**Table 4. Results of the regression analysis about the effect of independent variables related to the surgery condition on LFT changes**

Independent Variables	Dependent variables	Pump Time			Clamp Time			Inotrope			Balloon Pump		
		β	t	Sig	B	T	Sig	B	t	sig	β	t	sig
AST	ΔAST <sub>1</sub>	0.210	4.200	0.000	0.203	4.100	0.000	0.147	2.910	0.004	0.512	11.656	0.000
	ΔAST <sub>2</sub>	0.146	2.900	0.004	0.148	2.900	0.004	0.800	1.600	0.118	0.196	3.900	0.000
	ΔAST <sub>3</sub>	0.077	1.508	0.132	0.043	0.842	0.400	0.026	0.515	0.607	0.326	6.738	0.000
	ΔAST <sub>4</sub>	-0.001	-0.015	0.988	0.005	0.096	0.923	0.038	0.750	0.454	0.031	0.617	0.538
ALT	ΔALT <sub>1</sub>	0.086	1.690	0.092	0.086	1.693	0.091	0.083	1.634	0.103	0.477	10.630	0.000
	ΔALT <sub>2</sub>	0.093	1.821	0.069	0.113	2.219	0.027	0.049	0.959	0.338	0.473	10.514	0.000
	ΔALT <sub>3</sub>	0.069	1.361	0.174	0.056	1.106	0.270	0.022	0.426	0.670	0.470	10.418	0.000
	ΔALT <sub>4</sub>	0.018	0.342	0.732	0.038	0.737	0.462	-0.007	-0.141	0.888	0.212	4.245	0.000
ALP	ΔALP <sub>1</sub>	0.049	0.955	0.340	0.034	0.658	0.511	-0.014	-0.274	0.784	0.141	2.785	0.006
	ΔALP <sub>2</sub>	0.011	0.214	0.830	0.000	0.002	0.998	-0.047	-0.911	0.363	0.093	1.829	0.068
	ΔALP <sub>3</sub>	0.054	1.051	0.294	0.062	1.224	0.222	-0.064	-1.246	0.214	0.097	1.914	0.056
	ΔALP <sub>4</sub>	0.012	0.230	0.818	0.037	0.715	0.475	0.024	0.468	0.640	0.074	1.454	0.147
BiIT	ΔBiIT <sub>1</sub>	0.061	1.189	0.235	0.126	2.476	0.014	-0.023	-0.450	0.653	0.005	0.099	0.922
	ΔBiIT <sub>2</sub>	0.075	1.476	0.141	0.064	1.257	0.209	0.022	0.427	0.669	-0.015	-0.285	0.776
	ΔBiIT <sub>3</sub>	0.086	1.691	0.092	0.074	1.444	0.150	0.070	1.371	0.171	0.123	2.421	0.016
	ΔBiIT <sub>4</sub>	0.660	1.301	0.194	0.036	0.700	0.484	0.042	0.831	0.406	0.435	9.465	0.000
BiID	ΔBiID <sub>1</sub>	0.036	0.696	0.487	0.083	1.635	0.103	-0.024	-0.465	0.642	0.011	0.210	0.833
	ΔBiID <sub>2</sub>	0.040	0.780	0.436	0.085	1.661	0.098	0.045	0.875	0.382	0.015	0.285	0.776
	ΔBiID <sub>3</sub>	0.101	1.977	0.049	0.098	1.927	0.055	0.020	0.392	0.495	0.174	3.452	0.001
	ΔBiID <sub>4</sub>	0.065	1.279	0.202	0.037	0.715	0.475	0.011	0.220	0.826	0.358	7.501	0.000

\* The relationship will be significant at 95% confidence level, if  $|t| \geq 2$  or  $\text{sig} \leq 0.05$ .

AST; aspartate aminotransferase, ALT; alanine aminotransferase, ALP; alkaline phosphatase, BiIT; total bilirubin, BiID; direct bilirubin. Number after each of liver tests shows the post-surgical day which the test is obtained in Example ΔAST<sub>1</sub>; amount of increase of AST one day after surgery.

## Discussion

The pathogenesis of liver dysfunction after open heart surgery is multifactorial. According to Varghese et al. (2010) the most important cause is the alterations of liver perfusion during surgery (9). Due to the arrested systemic circulation and hypoperfusion, this organ is at risk of oxidative stress and ischemia. Previous researchers reported that nearly 10% of patients who underwent high-risk open heart surgery with

CPB, experienced some levels of liver injury (7). However, according to Raman et al. the likelihood for incidence of early and severe ischemic liver injury after heart surgery is low (1.1%) (12). In our study, in 12.9% of patients, the aminotransferases levels increased to more than three folds over normal upper limit but the probability for incidence of acute ischemic liver injury (transient increase in aminotransferases to over 500 IU/L during the first three days

of the following surgery) was 0.77%. Among the five LFT parameters including AST, ALT, ALP, total and direct bilirubin, except the ALP levels, all increased during the first 72 hours after the surgery and all of them returned to near normal ranges by the discharge time, which may represent occurrence of some acute and transient ischemic liver injury after CPB.

Sabzi et al. evaluated the changes in liver biochemical tests of 200 patients after on-pump CABG in 24, 48 and 72 hours after the surgery. According to their results, the LFT parameters increased significantly after the surgery as compared to the preoperative values. (Total bilirubin rose up to 20%, AST increased up to 7.3%, ALT increased up to 4% and ALP up to 34% in the third postoperative day) (8).

Our study has also achieved some similar results. The maximal change was in AST levels (increased up to 159% in the second postoperative day) which was predictable because this biomarker is nonspecific for liver and is likely, because of injuries to other organs and tissues. ALT, which is more specific for evaluating liver function, reached to its maximum level in the third postoperative day by increasing up to 69% along with a delay compared to AST. The time pattern of aminotransferases rise in this study was similar to the pattern of aminotransferases rise in ischemic liver injury (13). Total and direct bilirubin reached to maximum in the second postoperative day with an increase of 30-40%. Result of this study can represent that among LFT parameters, aminotransferases are more sensitive to detect liver injuries. LFT changes after heart surgery are more significant in the second and third postoperative days. (LFT changes after 24 hours following heart surgery are more noticeable). Here, we also evaluated the relationship between our dependent variables (LFT parameters) and the independent variables using regression model. In current study, type and techniques of the surgery, methods of induction and maintenance of anesthesia, selected drugs during the surgical procedure and amount of hypothermia were similar in all patients. Hence, only the impacts of pump time, cross-clamp time, use of inotropic drugs and intra-aortic balloon pump were studied.

According to the previous researches about CPB time, the prolonged pump time is related to incidence of more complications after CABG surgery. Regarding this fact that occurrence of non-pulsatile perfusion followed by a low blood flow and free radical formation disturbs oxygenation to tissues and organs, during the CPB process, long pump-time can increase the risk of ischemic injuries for organs like the liver

(14). Our results demonstrated that pump time could follow a significant direct correlation with AST and direct bilirubin changes, while the clamp time was observed to be directly correlated to AST, ALT and total bilirubin changes in the first 72 hours following the surgery. The above observations confirm the effective role of pump time and specially clamp time in the occurrence of liver injury after CPB and indicates the importance of expertness and promptitude in surgeons.

Inotropes used during and after the surgery to increase myocardial contractility, blood pressure and cardiac output, can also have negative side effects on the preload, afterload, heart rhythm and myocardial oxygen demand (15). Holmes et al. (2005) stated that using inotropic and vasoconstrictor agents could deteriorate peripheral tissues perfusion due to increasing peripheral vascular resistance (9). In current study, inotropic drugs were used in the first step in case of arterial pressure drop below 70 mmHg and deterioration of the patient's hemodynamic status. According to the results, there was only a direct significant correlation between inotropes infusion during the surgery and postoperative AST changes indicating the insignificant role of using inotropes in postoperative liver injury.

If the primary supportive strategies and catecholamine vasopressors failed to treat hypotension during the surgery, intra-aortic balloon pump (IABP) is used to improve circulatory failure. Therefore, the application of IABP can be considered as an indicator of critical hemodynamic condition. Ascione et al. (2006) suggested that using IABP during the heart surgery could be an effective factor in developing gastrointestinal complications especially liver related ones (10). According to the results of regression analysis in our study, there was a significant and direct correlation between using the IABP and the changes in all LFT parameters after the surgery confirming the previous results.

Furthermore, this study also deals with several cases related to the patients' risk factors. According to the previous studies, female gender could be one of the risk factors for low cardiac output after the surgery increasing the risk of ischemic liver injury following cardiac surgery (12). Our findings illustrated a significant and direct relationship between female gender and the total bilirubin changes at the discharge time compared to the preoperative levels (significant reverse correlation with male gender). We can possibly conclude that in females, the total bilirubin levels show a delay in returning to the normal values but whether it indicates that females are at more risk of complications and need more time for recovery

is not clear yet. However, in general, there was no significant relationship between the gender and LFT changes. Shahbazi et al.(2013) showed that except for ALP, all the other liver function test indices had a significant increase after on-pump CABG surgery ,they stated that preoperative central venous pressure had a significant relationship with the changes in AST and ALT ,also use of intra-aortic balloon pump and duration of aortic cross-clamp were significantly related to the changes in the liver function tests except for ALT and ALP (11).Dong et al. (2012) stated that old age was also a risk factor for gastrointestinal complications after heart surgery with CPB (4). Accordingly, based on our results, there was a significant direct correlation between age and changes of AST at discharge time from preoperative levels showing that older patients required a longer period of time for recovery and returning liver function to basal preoperative levels.

In the previous researches on the relationship between BMI and CABG outcomes, BMI was known as an independent predicting factor for complications and mortality after CABG surgery. Wagner et al. (2007) described a U-shaped correlation between BMI and CABG morbidity and mortality and the minimum risk is near 30 kg/m<sup>2</sup> (16). In our study, BMI level showed reverse correlation to total and direct bilirubin changes after the surgery indicating that lower postoperative bilirubin levels could be expected for higher BMI levels.Previous history of myocardial infarction and EF of less than 40% are accepted as effective independent factors in gastrointestinal complications after cardiac surgery (17). In this research, EF levels had a significant reverse correlation with postoperative AST in the second and third days, as well as direct bilirubin changes on the third day revealing the role of a low cardiac ejection fraction in occurring some levels of liver injury after CPB.

Among the four cardiovascular risk factors in our study, we could hardly observe significant correlations. The significant relationship between the history of myocardial infarction and the increase in total bilirubin levels during the first 48 hours after the surgery shall be excluded from the above conclusion.There was also a significant direct relationship between smoking and changes of AST and direct bilirubin during the first 72 hours following the surgery. In addition, history of opium addiction had a significant and direct correlation with AST level changes in the third postoperative day.

As a result, smoking cigarettes and opium were found effective in occurring some levels of liver injury. In the study

conducted by Mangi et al. (2005), smoking has been considered as a risk factor for mortality due to the gastrointestinal complications (18). Our study had limitations too,retrospectiveness of the study could affect extraction of the of information details and interpretation of the relationship between variables,also definitely a study with larger population of patients could have more accurate statistical results.

Considering our results, although in patients undergoing non emergent CABG surgery, rise of liver biochemical tests after surgery is not uncommon ,significant and severe liver injury occurs in very few of them and in most cases, liver function tests returns to near normal ranges by the discharge time. Pump time and clamp time are the most effective factors for incidence of acute liver injury after the on-pump CABG surgery indicating the important role of expertness and promptitude in surgeons and also the necessity of using techniques for reducing CPB time.

Due to the significant relationship between using intra-aortic balloon pump and LFT changes, in the surgeries which used these tools, it is necessary to expect probable liver injuries post inserting IABP and consider exact monitoring and treatments for this complication.

Also patients with older age, previous history of MI,Low cardiac ejection fraction,cigarette smoking and opium consumers have more susceptibility in changes of biochemical liver tests after surgery, Studies with larger population of patients and evaluation of more detailed parameters will achieve more comprehensive results.

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