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Comparative Efficacy of Surgical Interventions for Cardiac Trauma: With and Without Cardiopulmonary Bypass

Conflict of interest: nothing to declare.

Authors' contribution: Laith Fathi Sharba – conceptualization, data curation, methodology, project administration, resources, software, writing – original draft and editing; Laith Saleh Abood – conceptualization, data curation, resources, validation, visualization, writing – original draft and editing; Ahmed Muhi Fahad – conceptualization, resources, validation, visualization, writing – original draft and editing.

The article is published in author's edition.

Submitted: 11.11.2024

Accepted: 11.02.2025

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Abstract

Introduction. Heart injuries are life-threatening conditions that necessitate rapid interference to save patients. Using bypass machine improve the accessibility to a wide range of surgeries that could not be done previously or in theaters where no availability of cardiopulmonary bypass (CPB) machines.

Purpose. To compare operative conditions and availability of surgical interventions in heart injuries performed with or without cardiopulmonary bypass.

Materials and methods. This study was done on 29 patients with sustained penetrating cardiac trauma who subsequently underwent surgical intervention at two medical centers in Iraq between 2008 and 2014. Sixteen patients were treated without CPB at the Najaf Thoracic Teaching Center, while thirteen patients underwent procedures with CPB at the Iraqi Center for Heart Diseases in Baghdad. Perioperative chest X-rays were performed to assist with the localization of foreign bodies.

Results. Patients presenting in shock underwent surgery without the use of cardiopulmonary bypass (CPB). In contrast, stable patients – defined as those with a systolic BP above 80 mmHg – underwent surgery on CPB, except four patients who did not require CPB.

Conclusion. The choice of surgical approach – whether with or without CPB – must be carefully considered based on the patient's general condition and the nature of their injury. The study's findings advocate for a flexible and adaptive approach to managing penetrating cardiac trauma, with the ultimate goal of achieving the best possible outcomes for patients.

Keywords: cardiac trauma, cardiopulmonary bypass, heart injuries, hemorrhage



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Сравнительный анализ эффективности хирургических вмешательств при травмах сердца с применением искусственного кровообращения и без него

Конфликт интересов: не заявлен.

Вклад авторов: Лаит Фатхи Шарба – концепция исследования, обработка данных, методология, управление проектом, ресурсы, программное обеспечение, написание чернового варианта статьи, редактирование; Лаит Салех Абуд – концепция исследования, обработка данных, ресурсы, проверка достоверности полученных данных, визуализация, написание чернового варианта статьи, редактирование; Ахмед Мухи Фахад – концепция исследования, ресурсы, проверка достоверности полученных данных, визуализация, написание чернового варианта статьи, редактирование. Статья опубликована в авторской редакции.

Подана: 11.11.2024

Принята: 11.02.2025

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Резюме

Введение. Повреждения сердца – опасные состояния, требующие принятия незамедлительных мер для спасения жизни пациентов. Использование аппаратов искусственного кровообращения увеличивает возможность проведения широкого спектра операций, которые невозможно было выполнить ранее или ввиду их отсутствия в операционных.

Цель. Сравнить условия проведения и доступность хирургических вмешательств при повреждениях сердца, выполняемых с использованием искусственного кровообращения и без него.

Материалы и методы. В данном исследовании приняли участие 29 пациентов с проникающими травмами в области сердца, которым были проведены хирургические вмешательства в двух медицинских центрах Ирака в период с 2008 по 2014 г. 16 пациентов были прооперированы без использования искусственного кровообращения в учебном центре торакальной хирургии в Наджафе, а 13 – подверглись хирургическому вмешательству с применением искусственного кровообращения в Иракском центре сердечных заболеваний (Багдад). Для выявления инородных тел проводилась периоперационная рентгенография грудной клетки.

Результаты. Пациенты, поступившие в лечебные заведения в состоянии шока, были прооперированы без применения искусственного кровообращения. В отличие от них стабильные пациенты, определяемые как пациенты с систолическим давлением выше 80 мм рт. ст., были прооперированы с использованием искусственного кровообращения, за исключением 4 пациентов, которым оно не потребовалось.

Заключение. Результаты исследования свидетельствуют в пользу гибкого и адаптивного подхода к лечению проникающих травм сердца, конечной целью которого является достижение наилучшего исхода для пациента.

Ключевые слова: травма сердца, искусственное кровообращение, повреждения сердца, кровотечение

■ INTRODUCTION

Heart injuries are considered life-threatening conditions that necessitate rapid and effective interference to save patients and improve their survival [1]. Using bypass machine improve the accessibility to a wide range of surgeries that could not be done previously or in theaters where no availability of cardiopulmonary bypass (CPB) machines [2–4]. This study reveals the comparative condition and accessibility of surgical interventions for cardiac injury performed with and without CPB machines [5]. By examining the advantages, narrowing, and clinical outcomes associated with both approaches, this study aims to provide an understanding of the current practices and reveal future advancements in the surgical management of cardiac trauma [6, 7].

This comprehensive approach enabled effective management of penetrating cardiac trauma, tailored to the presence or absence of cardiopulmonary bypass, ensuring optimized outcomes for the patients involved.

■ PURPOSE OF THE STUDY

To compare operative conditions and availability of surgical interventions in heart injuries performed with or without cardiopulmonary bypass.

■ MATERIALS AND METHODS

A retrospective study was done on 29 patients with sustained penetrating cardiac trauma who subsequently underwent surgical intervention at two medical centers in Iraq between 2008 and 2014. Sixteen patients were treated without CPB at the Najaf Thoracic Teaching Center, while thirteen patients underwent procedures with CPB at the Iraqi Center for Heart Diseases in Baghdad. Perioperative chest X-rays were performed to assist with the localization of foreign bodies.

A. Procedures without cardiopulmonary bypass

At the Najaf Vascular Center, ten patients underwent urgent left anterior or anterolateral thoracotomy, with one patient requiring right thoracotomy due to a massive air leak from that side and another patient requiring median sternotomy due to the location of the injury. Cardiorrhaphy was performed using transverse per-string sutures with 3–0 prolene and pledgets. Hemorrhage control was initially achieved using a Foley catheter, particularly in hemodynamically unstable patients, as a temporary measure to facilitate urgent blood transfusions. In other cases, direct pressure was applied. All foreign bodies, including bullets and shell fragments, were removed when present. The pericardium was closed with interrupted sutures, and a drain was left in place and connected to an underwater seal. Postoperatively, patients were transferred for monitoring to the intensive care unit, with the duration of stay dependent on their overall condition.

B. Procedures with cardiopulmonary bypass

The standard surgical approach involved median sternotomy. Full heparinization was administered when CPB was utilized. Femoral-femoral bypass preparation, aortic and bicaval cannulation, and cardiopulmonary bypass with topical and central cooling were performed. An aortic cross-clamp was applied, and cardioplegic arrest was induced. Intracavitary foreign bodies were accessed either through left or right atriotomy incisions or transverse aortotomy. The aorta was cross-clamped quickly with minimal cardiac manipulation to prevent systemic or pulmonary embolization of intracavitary foreign bodies. Intracavitary defects were closed directly or with a glutaraldehyde-tanned pericardial patch using continuous 4-0 monofilament prolene sutures. Cardiorrhaphy was executed using 3-0 pledged prolene sutures, and bio-glue was applied to secure hemostasis.

Statistical analysis

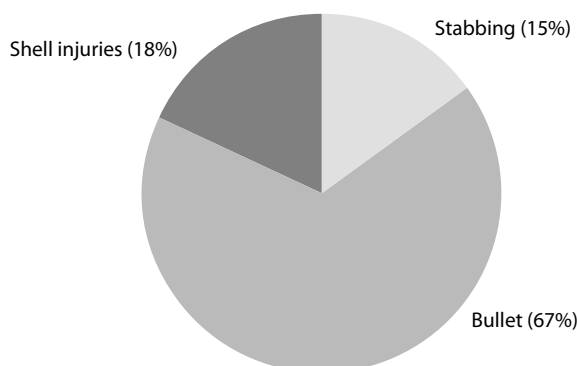
Use of statistics to show the correlation between each type of intervention with or without the Bypass machine considering the P-value significant if it is less than 0.05.

■ RESULTS

Data were collected from 29 patients, consisting of four women and 25 male, with ages from 7 to 62 years with a mean age of 26.8 years.

The mechanism of cardiac injuries showed in Figure. Shell injuries recorded in 18%, stabbing wound recorded in 15% whereas the most patient suffered from bullet injuries (67%).

Patients presenting in shock underwent surgery without the use of cardiopulmonary bypass (CPB). In contrast, stable patients – defined as those with a BP above 80 mmHg – underwent surgery on CPB, except four patients who did not require CPB. Significant correlations were identified between patients' hemodynamic states and the surgical approaches employed, such as sternotomy or left thoracotomy, although right thoracotomy did not demonstrate such correlations. Notably, procedures like atrial septal defect closure or cardiorrhaphy were found to have highly significant or significant correlations with these approaches, respectively. The majority of patients who did not require CPB



Mechanism of injuries

Detailed data regarding the use of CPB or the absence

	With Bypass	Without	Total	Chi-square	P-value
Number	13	16	29		
Bullet injuries	13	12	25		
Stab injuries	–	4	4		
Stable (Systolic more than 80mmHg)	13	4	17	4.765	0.029
Unstable (less than 80mmHg)	–	12	12	12	0.00053
Left thoracotomy	–	10	10	10	0.00156
Median sternotomy	13	1	14	10.286	0.00134
Right thoracotomy	–	1	1	1	0.317
Interventricular septum injuries	3 (Closure)	1 (later closure)	4	1	0.317
Ventricular wall	6	16	22	4.545	0.033
ASD closure	7	–	7	7	0.0081
Aortic Valve Repair	1	–	1	1	0.317
Aortopulmonary fistula repair	1	–	1	1	0.317
Left atrial appendage trans fixation	1	–	1	1	0.317
Right atrial per strung (Foley catheter)	–	1	1	1	0.317

were operated on via left thoracotomy, whereas median sternotomy was preferred when CPB was necessary. Patients with suspected intracardiac injuries and stable hemodynamic states were transferred to a center equipped with CPB. Conversely, all unstable patients underwent surgery without CPB and did not require additional definitive surgery later, except one patient who required ventricular septal defect closure at a later time (Table).

■ DISCUSSION

This study involved 25 patients who underwent cardiac surgeries across two centers in Iraq, one of which utilized CPB while the other did not. A cohort study was conducted to evaluate the outcomes of each intervention, with data subjected to statistical analysis to determine the significance of various parameters in relation to the type of operations performed.

The patient's hemodynamic stability was a critical factor in decision-making regarding the use of CPB [8]. As the results indicate, hemodynamically unstable patients, characterized by a Bp of less than 80 mmHg, were prioritized for immediate surgical intervention without CPB [9].

Critically unstable patients who need urgent intervention were more suitable for this approach, temporary bleeding stoppage through the use of Foley catheter insertion through the injury sites was commonly used in our practice allowing rapid stabilization and sometimes facilitating large amounts of blood transfusion to maintain hemodynamic stable patients before definitive surgery [10-14]. This is similar to the study done by Symbas et al. [1] which demonstrates that immediate interference using urgent thoracotomy without CPB yields a survival rate of 84% this is similar to a study of Ivatury et al. [4], so supporting our study.

On the other hand, stable patients (systolic BP above 80 mmHg), mostly underwent cardiac surgeries with CPB especially when intracardiac injuries were suspected like atrial or ventricular septal defect or valvular injuries [12]. The use of CPB enables surgeons to carefully assess the defect and repair it while minimizing manipulation of the heart and



decreasing the risk of pulmonary or systemic embolization [11, 13]. This is consistent with the results of Asensio et al. study (1998) which found that CPB facilitated complex intracardiac repair in selected patients [7]. This is also supported by study done by Richens et al. (2002) shown that in addition to the above conclusion it reduces the risk of embolization and other complications [10].

Our study found that significant correlation between surgical approaches and the need for CPB was significant, however, a median sternotomy was usually used with CPB, and left thoracotomy was used when no CPB needed it, however, there were cases in our study where sternotomy was done for the patient without bypass need and there was one patient underwent right thoracotomy for his right massive air leak. It is well known now CPB could be done with thoracotomy instead of sternotomy so it is no matter now the way of surgical incisions with the need for CPB correlation [13–15]. Studies like those by Burack et al. (2008) selected the use of CPB depending on the complexity of cardiac injuries in addition to the patient's general condition [13].

■ CONCLUSION

The choice of surgical approach – whether with or without CPB – must be carefully considered based on the patient's general condition and the nature of their injury. The study's findings advocate for a flexible and adaptive approach to managing penetrating cardiac trauma, with the ultimate goal of achieving the best possible outcomes for patients. Future studies with larger sizes are recommended to further validate these findings and may remodeling surgical guidelines for this challenging and life-threatening condition.

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