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Research Article

Central vs Peripheral Cannulation in Redo Cardiac Surgery - A 10-Year Review

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Abstract

Objective: This study aimed to compare the outcomes of central versus peripheral cannulation strategies in redo cardiac surgery over a 10-year period at a single institution.

Methods: A retrospective analysis was conducted on 94 patients undergoing redo coronary, tricuspid, or mitral surgery between 2013 and 2023. Patients were divided into central (n=51) and peripheral (n=43) cannulation groups. Operative parameters, postoperative complications, and mortality were compared.

Results: No significant differences were observed between the groups in terms of EuroSCORE (5% vs 4.5%, p=0.42), cross-clamp time (98 vs 93 minutes, p=0.19), cardiopulmonary bypass time (158 vs 144 minutes, p=0.26), or length of operation (322 vs 329 minutes, p=0.19). The incidence of major complications, including myocardial injury, bleeding, and innominate vein damage, was similar between groups. Postoperative atrial fibrillation (22% vs 23%, p=0.29), renal failure (4% vs 7%, p=0.29), stroke (6% vs 7%, p=0.34), and in-hospital mortality (6% vs 9%, p=0.42) rates were comparable.

Conclusion: This study demonstrates that central cannulation is a safe and effective approach in redo cardiac surgery when performed with meticulous planning and appropriate surgical techniques. Both central and peripheral cannulation strategies yielded similar outcomes, suggesting that the choice of cannulation strategy should be individualised based on patient-specific factors and surgical expertise.

Introduction

Redo cardiac surgery poses significant challenges, necessitating meticulous planning at every stage of the procedure. One critical aspect that demands careful consideration is the cannulation strategy employed. Cardiac surgery is an intricate and delicate process, and in redo cases, the proximity of vital structures behind the sternum renders sternotomy an extremely high-risk endeavour for potential bleeding complications [1]. The presence of dense adhesions and scar tissue from previous operations can increase the risk of injury to crucial structures, such as the heart, great vessels, and bypass grafts, during sternal re-entry [2]. To mitigate these risks, peripheral cannulation has gained popularity as an alternative approach in redo cardiac surgery [3]. This technique involves establishing cardiopulmonary bypass through alternative sites, such as the femoral or axillary vessels, circumventing the need for extensive dissection in the mediastinal region. By avoiding sternal re-entry, peripheral cannulation minimises the risk of injury to mediastinal structures and can facilitate minimally invasive surgical approaches [4]. Additionally, peripheral cannulation may offer advantages in patients with severe aortic calcification or scarring, where central cannulation may be challenging or associated with increased risk [5]. While peripheral cannulation offers advantages, including reduced risk of injury to mediastinal structures and potential for minimally invasive approaches, routine use of this strategy may not be necessary [4]. Central cannulation, which involves direct aortic and venous cannulation, remains a viable option with favourable outcomes when executed with the appropriate precautions [6,7]. In experienced hands,

central cannulation can be performed safely, even in complex redo cases, by employing meticulous dissection techniques and careful handling of adhesions [8]. However, when pursuing central cannulation in redo cases, meticulous attention must be given to preventing injury to key structures during sternal re-entry, such as the right ventricle, aorta, and patent Left Internal Mammary Artery (LIMA) to Left Anterior Descending (LAD) artery graft [9]. Inadvertent injury to these structures can lead to catastrophic bleeding, myocardial ischemia, or graft dysfunction, significantly impacting patient outcomes [1]. Recent studies have compared the outcomes of central and peripheral cannulation strategies in redo cardiac surgery. A retrospective study of 258 patients undergoing cardiac reoperation found that both techniques can be safely employed, with the choice depending on individual patient factors and surgeon preference [10]. Another study evaluating the long-term impact of cannulation strategies in redo cardiac surgery suggested that central cannulation may be the preferred approach whenever safe and possible [11] This study aims to review our institution's experience with central versus peripheral cannulation strategies in redo cardiac surgery over a 10-year period. By evaluating the outcomes and potential complications associated with each approach, we strive to provide valuable insights to guide surgical decision-making and optimise patient outcomes in this challenging subset of cardiac procedures.

Materials and Methods

Study Design and Patient Selection

This single-centre retrospective study included patients who underwent redo coronary, tricuspid, or mitral surgery at our institution between January 2013 and December 2023. Patients eligible for inclusion were divided into two groups based on the cannulation strategy employed: central cannulation and peripheral cannulation (Figure 1).

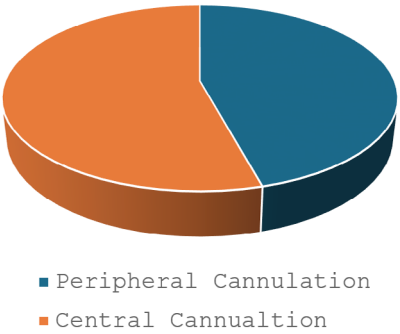

Figure 1: Patients Undergoing Redo Surgery over past 10 years

Data Collection

Using operative notes, perfusion data and electronic medical records, we collected and compared the various operative and immediate post-operative factors between the two groups [3,6,9]. The collected data included demographic information, preoperative risk factors, operative details, Cardiopulmonary Bypass (CPB) parameters, and postoperative outcomes. Preoperative risk factors assessed included age, sex, Body Mass Index (BMI), diabetes mellitus, hypertension, Chronic Obstructive Pulmonary Disease (COPD), peripheral vascular disease, renal insufficiency, and ejection fraction. Operative details encompassed the type of procedure performed, the urgency of the operation, and the specific cannulation sites used. CPB parameters included CPB time, cross-clamp time, and the need for circulatory arrest. Postoperative outcomes evaluated included mortality, stroke, renal failure requiring dialysis, prolonged ventilation (>24 hours), reoperation for bleeding, and Intensive Care Unit (ICU) and hospital length of stay.

Surgical Technique

All operations were performed with moderate hypothermia (28-32°C) and using both anterograde and retrograde cardioplegia for myocardial protection [4,12]. Re-sternotomy was performed using an oscillating saw to minimise the risk of injury to underlying structures [4]. The decision to employ central or peripheral cannulation was made by the attending surgeon based on preoperative assessment and intraoperative findings.

Central Cannulation

In the central cannulation group, the aorta was directly cannulated for arterial inflow, and the right atrium or superior vena cava was cannulated for venous drainage [4]. Careful dissection and adhesiolysis were performed to expose the appropriate cannulation sites, with particular attention given to avoiding injury to vital structures, such as the right ventricle, aorta, and LIMA grafts.

Peripheral Cannulation

In the peripheral cannulation group, alternative sites were used for arterial inflow and venous drainage. Common sites included the femoral artery and vein, as well as the axillary artery [3,8]. Percutaneous techniques or limited surgical exposure were employed to establish the cannulation sites, minimising the need for extensive dissection in the mediastinal region.

Statistical Analysis

Appropriate statistical methods were employed to analyse the collected data. Continuous variables were reported as mean ± standard deviation or median (interquartile range), depending on the distribution. Categorical variables were reported as frequencies and percentages. Comparisons between the central and peripheral cannulation groups were performed using Student's t-test or Mann-Whitney U test for continuous variables and Chi-squared or Fisher's exact test for categorical variables. Multivariable

logistic regression analysis was conducted to identify independent predictors of mortality and major adverse events, adjusting for potential confounding factors. A p-value < 0.05 was considered statistically significant. Statistical analyses were performed using SPSS software (version 25.0, IBM Corp., Armonk, NY, USA).

Results

A total of 94 patients were included in the study, with 51 (54%) patients undergoing central cannulation and 43 (46%) undergoing peripheral cannulation. The calculated European System for Cardiac Operative Risk Evaluation (EuroSCORE) was similar, with no significant difference (5% vs 4.5%, p = 0.42, central vs. peripheral) observed between the two groups. Both cannulation strategies involved comparable cross-clamp time (98 vs 93 minutes, p = 0.19), Cardiopulmonary Bypass (CPB) time (158 vs 144 minutes, p = 0.26), and length of operation (322 vs 329 minutes, p = 0.19) for central and peripheral cannulation, respectively. Regarding significant complications, there was no difference between the two groups in the incidence of myocardial injury, bleeding, or innominate vein damage (1 vs 1, central vs. peripheral). Operative mortality was similar between the central and peripheral cannulation groups. In the peripheral cannulation group, no cases of femoral artery dissection or pseudoaneurysm requiring treatment were reported. Postoperatively, the rates of atrial fibrillation (11 [22%] vs. 10 [23%], p = 0.29), renal failure (2 [4%] vs 3 [7%], p = 0.29), and stroke (3 [6%] vs 3 [7%], p = 0.34) did not differ significantly between the central and peripheral cannulation groups, respectively. The in-hospital mortality rate was comparable between the two groups (3 [6%] vs. 4 [9%], p = 0.42, central vs. peripheral) (Tables 1&2) (Figure 2).

	Central	Peripheral	P Value
Number of patients	51	43	
Age (mean)	62	64	P=0.23
Gender	24M 27F	30M 13F	P=0.17
Renal Disease	3	5	P=0.5
Peripheral Vascular Disease	3	3	P=0.42
Chronic Lung Disease	5	6	P=0.27
Active endocarditis	4	4	P=0.5
Ejection Fraction (Mean)	56%	52%	P=0.19

Table 1: Demographics of central and peripheral cannulation groups.

	Central	Peripheral	P Value
Cross Clamp (m)	98	93	P=0.19
Bypass time (m)	158	144	P=0.26
Length operation (m)	322	329	P=0.19
Euroscore	5	4.5	P=0.42
AF	11	10	P=0.29
Renal Failure	2	3	P=0.29
Stroke	3	3	P=0.34
In hospital death	3	4	P=0.42

Table 2: Intraoperative and postoperative factors between central and peripheral cannulation groups.

Figure 2a: 'Peripheral' Cannulation group- femoral artery and vein.

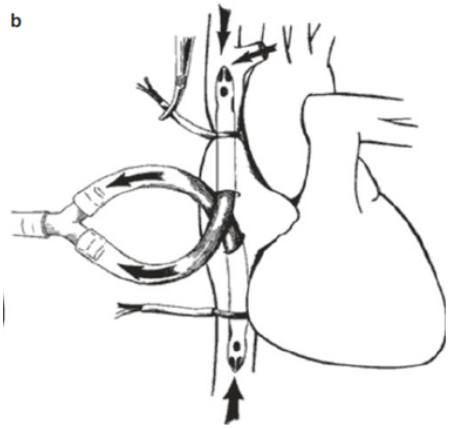

Figure 2b: 'Central' - aorta and right atrium or bicaval cannulation.

Discussion

The present study aimed to evaluate the outcomes of central versus peripheral cannulation strategies in redo cardiac surgery at our institution over a 10-year period. The findings demonstrate that both approaches yielded comparable results in terms of operative parameters and postoperative complications, suggesting that either strategy can be employed successfully in experienced hands with appropriate precautions. One key observation from our study is that the bypass and cross-clamp times did not significantly differ between the central and peripheral cannulation groups [3]. These parameters are important indicators of the overall complexity and duration of the procedure, and their similarity across both groups suggests that neither approach inherently prolonged the surgical duration or required excessive myocardial ischemic time. Furthermore, our results revealed no significant differences in the incidence of major postoperative complications, including myocardial injury, bleeding, and innominate vein damage, between the two cannulation strategies [4]. This finding underscores the safety and feasibility of both approaches when undertaken with appropriate precautions and surgical expertise. Peripheral cannulation offers several advantages, such as decompression of the heart and decreased pressure on major arteries, which can be beneficial in emergency situations [5]. Additionally, the ability to establish cardiopulmonary bypass before extensive dissection can provide a safer operative field and facilitate minimally invasive approaches [12]. However, peripheral cannulation is not without drawbacks, including the potential for femoral artery dissection, pseudoaneurysm formation, limited applicability in patients with peripheral vascular disease, and the need for early heparinisation [4].

Recent studies [7,10] reported peripheral cannulation for cardiopulmonary bypass in cardiac reoperations is associated with higher risk of acute renal failure compared to central cannulation, while both techniques show comparable early mortality rates. Notably, our data demonstrate that central cannulation can be performed safely and effectively in redo cardiac surgery when appropriate techniques are employed. Preoperative imaging, such as Computed Tomography (CT) and angiography, plays a crucial role in determining the proximity of the aorta to the sternum and identifying the presence and location of patent Left Internal Mammary Artery (LIMA) grafts [8,13]. Intraoperatively, meticulous surgical techniques are essential, including the removal of sternal wires after sternotomy, lung hyperinflation, the use of an oscillating saw at the appropriate angle, and the placement of Ethibond sutures to lift the sternum [9]. Additionally, minimising dissection in the left ventricular and apical regions can further reduce the risk of injury to vital structures.Furthermore, a single centre study involving 177 patients undergoing type A acute aortic dissection by Klot et al highlighted similar outcomes in both approaches (peripheral versus central cannulation [14,15] Our study acknowledges Minimally Invasive Cardiac Surgery (MICS) has gained popularity due to its potential benefits, yet literature is notably scarce on a specific technique: the right vertical infra-axillary thoracotomy approach without peripheral cannulation in adults. This approach is significant for avoiding complications associated with peripheral cannulation, such as limb ischemia and vascular injury [15].

While both central and peripheral cannulation strategies have their respective advantages and disadvantages, our study highlights that in experienced hands, central cannulation can be a safe and viable option for redo cardiac surgery. Careful patient selection, preoperative planning, and meticulous surgical technique are paramount to mitigating the risks associated with central cannulation and achieving favourable outcomes.

Conclusion

The findings of our study demonstrate that central cannulation is an effective and safe approach in redo cardiac surgery when performed with meticulous planning and appropriate surgical techniques. While peripheral cannulation offers certain advantages, such as reduced risk of injury to mediastinal structures and potential for minimally invasive approaches, our results indicate that central cannulation can be employed without compromising patient outcomes or increasing the risk of significant complications. Careful preoperative planning and patient selection are crucial when determining the optimal cannulation strategy for redo cardiac surgery. Factors such as the presence of patent grafts, aortic pathology, and the proximity of vital structures to the sternum should be thoroughly evaluated using advanced imaging modalities, including computed tomography and angiography. This comprehensive assessment allows for the identification of high-risk patients who may benefit from a peripheral cannulation approach. However, our study reinforces the notion that this strategy can be employed safely and effectively for patients deemed suitable for central cannulation.

By adhering to meticulous surgical techniques, such as the use of an oscillating saw at the appropriate angle, the placement of Ethibond sutures to lift the sternum, and minimising dissection in the left ventricular and apical regions, the risk of injury to critical structures during sternal re-entry can be significantly reduced. Ultimately, the decision to pursue central or peripheral cannulation in redo cardiac surgery should be individualised based on patient-specific factors and guided by the experience and expertise of the surgical team. By employing a tailored approach and adhering to best practices, the risks associated with redo cardiac surgery can be mitigated, leading to improved patient outcomes and reduced morbidity and mortality. In conclusion, our study reinforces the safety and efficacy of central cannulation in redo cardiac surgery

when appropriate precautions and techniques are employed. Careful preoperative planning, patient selection, and meticulous surgical execution are paramount to ensuring successful outcomes and minimising complications associated with this challenging subset of cardiac procedures.

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