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Zero Re-Entry Site Injury in Redo Cases: A New Easy, Safe and Reproducible Femoral Vein Cannulation Technique

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ABSTRACT

Background: Despite high progress in surgical techniques and medical strategies, mortality seems higher in redo cases than in primary surgery. Redo cardiac surgery is challenging. Scarring of tissues leading to loss of anatomical planes and adhesions increases the risk of injury during re-entry. It is important to implement safe strategies to prevent such injuries in this cohort of patients.

Objectives: We investigated the outcome of redo patients with a new simple, reproducible technique using pre-operative chest computed tomography without contrast and peripheral femoral site cannulation with the use of a new technique of femoral venous cannulation and initiation of cardiopulmonary bypass pre-sternotomy in redo patients.

Patients and Methods: A prospective analytical study involved 97 redo patients between July 2018 and June 2021. All patients were operated by the same surgical technique involved pre sternotomy femoral cannulation and initiation of cardiopulmonary bypass. All patients candidate for redo surgery were involved, there were no exclusion criteria, we used our modified technique for peripheral femoral cannulation using a simple, reproducible, and safe strategy to avoid fatal re-entry injuries.

Results: There was no re-entry site injury, very low peripheral femoral site cannulation complications, and hospital mortality 6% due to other causes rather than fatal re-entry site injury.

Conclusion: We believe that our simple modified technique of pre-operative mandatory CT scan of the chest, and pre-sternotomy peripheral femoral cannulation, and initiation of CPB were very promising in achieving zero re-entry site injury in redo cardiac surgery cases.

Keywords: Re-entry site injury, Redo cardiac surgery, Femoral venous cannulation.

INTRODUCTION

The number of patients performing cardiac surgeries increased due to the increase in life expectancy dramatically, cohort of patients requiring redo surgery is not uncommon. Despite major progress in technology, and recent advanced techniques, redo cardiac surgery still carries a higher risk of mortality and morbidity rates than primary surgery [(1,2)].

Redo cardiac surgery can be performed with conventional aortic and venous cannulation after sternotomy or, by arterial and venous cannulation before sternotomy through different methods of peripheral cannulation [(2)].

Due to increased operative and technical skills and intensive care units high potentials there is better long-term survival following cardiac surgery. In recent years, surgeons became highly encountered in re-doing more complex surgically and medically demanding cardiac surgeries [(3)]. D

espite high progress in surgical techniques and medical strategies, mortality seems higher in redo cases than in primary surgery. Redo cardiac surgery is challenging. Scarring of tissues leading to loss of anatomical planes and adhesions increases the risk of injury during re-entry. It is important to implement safe strategies to prevent such injuries in this cohort of patients [(4)].

PATIENTS AND METHODS

A prospective analytical study involved 97 redo patients between July 2018 and June 2021 at Kasr Alainy Hospitals. All patients were operated by the same surgical technique involved pre- sternotomy femoral cannulation and initiation of cardiopulmonary bypass. All patients candidate for redo surgery were involved, there were no exclusion criteria. We used our modified technique for peripheral femoral cannulation using a simple, reproducible, and safe strategy to avoid fatal re-entry injuries.

Preoperative evaluation:

All patients scheduled for redo surgery had the usual routine pre-operative evaluation for any primary patients included full laboratory investigations, plain posteroanterior chest XRay(CXR), echocardiography, carotid duplex for any patient more than 45 years old or history of stroke, coronary angiography for patients more than 40 years or redo coronary artery bypass grafting, moreover, we ordered lateral view plain X-ray and CT chest without contrast and arterial both lower limbs duplex for every patient.

Redo cardiac surgery technique:

In 89 patients, we started the operation with cannulation of the right common femoral artery, in 8 patients we cannulated the left common femoral artery due to significant atherosclerotic conditions in the right

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lower limb arterial tree. We routinely used, the right common femoral vein cannulation; in all cases except cases when the left common femoral artery was the site of intervention. The common femoral artery is always cannulated with Poly Tetra Fluoro Ethylene (PTFE) 8 mm tube graft.

The tip and trick we introduced here is the way we dealt with the venous axis, for years, the standard double staged long venous cannula was the standard level of care for the femoral venous site cannulation, but complications of this type of cannulas may happen and if so can end catastrophic, also, its technique of insertion necessitates the presence of trans-esophageal echocardiography and more demanding in comparison to our modification.

In our technique, we introduced a new trick by using a right-angled plastic or metal tip cannula for cannulation of the venous site axis.

We used a 5/0 oblong prolene suture as a purse in the common femoral vein then through it we cannulate the venous axis site by metal tip or right-angled plastic venous cannulas, we used the biggest possible available cannula usually 32 or 34 to assure maximum possible venous drainage (Figure 1).

After this, we initiated the cardiopulmonary bypass before sternotomy with the maximum possible flow, and mild systemic hypothermia (30 °C) was achieved.

As usual in redo cases, we used an oscillating saw to divide the sternum. When we divide the posterior table of the sternum, we remove the wires and a careful meticulous sharp dissection was done using electrocautery and/or scissors. The dissection starts close to the sternum along the diaphragmatic surface and then progresses towards the right atrium then to the aorta. Dissection was performed slowly and gently towards the aorta to avoid extension and beneath the adventitia. Dissection on the left side was completed on the arrested heart after cross-clamp.

The heart was never dissected more than necessary to complete the planned operation safely. First, we cannulate the aorta, at that point we initiate antegrade flow and stop the retrograde one through the femoral axis, then we start to dissect the venous axis site according to the type of operation, when we complete atrial venous cannulation we proceed to remove the cannula from femoral venous axis site, we used antegrade intermittent cold cardioplegia in all cases.

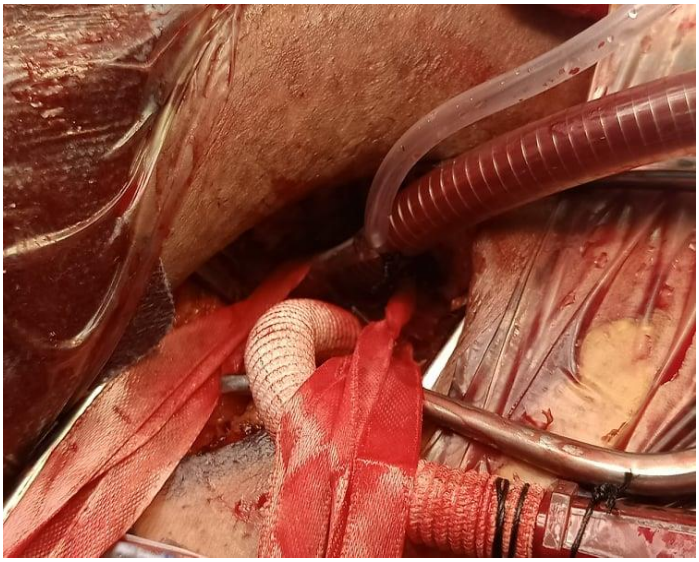

Fig. (1): Peripheral femoro-femoral cannulation.

Ethical approval:

The study was approved by the Ethics Board of Cairo University and an informed written consent was taken from each participant in the study. This work has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans.

Statistical Methods

Data were statistically described in terms of mean ± standard deviation (± S.D), frequencies (number of cases), and percentages when appropriate. Comparison of numerical variables between the study groups was done using the Student *t*-test for independent samples. For comparing categorical data, Chi-square (χ^2) test was performed. The exact test was used instead when the expected frequency is less than 5. *p*-values less than 0.05 were considered statistically significant. All statistical calculations were done using computer programs SPSS (Statistical Package for the Social Science; SPSS Inc., Chicago, IL, USA) version 15 for Microsoft Windows.

RESULTS

All pre-operative and operative characteristics are summarized in **table (1),** all patients had preoperative CT scans, all were peripherally cannulated through the femoral axis before sternotomy.

Table (1): Patient characteristics.

Variables	
Preoperative	
Age (years)	58 ± 11
Male gender	63 (65%)
Left ventricular function <50%	27 (28%)
Body mass index	22 ± 3
Chronic obstructive pulmonary disease	16 (15%)
Diabetes mellitus	18 (19%)
Renal failure needing dialysis	5 (5%)
Operative priority (urgent, emergency)	28(29%)
Previous sternotomy >1	17 (17%)
Previous coronary artery bypass graft	23 (24%)
Pulmonary artery pressure (mmHg)	42 ± 12
Preoperative computerized tomography scan	97 (100%)
Operative	
Peripheral arterial cannulation	97 (100%)
Cardiopulmonary bypass time (min)	135± 22
Cross-clamp time (min)	87±13
Re-entry injury	0 (0%)
Early outcomes	
The median length of stay	11 (7, 20)
In-hospital mortality	6 (6%)

Table (2): Indications for redo surgery.

Indications for surgery	*n* (%)
Valvular disease	57(58)
Coronary artery disease	12 (12)
Mixed coronary artery disease + valve	5 (5)
Prosthetic valve endocarditis	13 (13)
Paravalvular leak	7(7)
Ascending aortic aneurysm	3 (3)

DISCUSSION

The number of patients requiring redo cardiac surgery is not uncommon. Despite advances in medical treatment, technology, and techniques, redo cardiac surgery is still challenging and carries certain mortality and morbidity rates [1,2]. We can perform Redo cardiac surgery with conventional aortic and venous cannulation after sternotomy or with arterial and venous cannulation prior to sternotomy through different methods of peripheral cannulation [2]. Improved long-term survival after cardiac surgery can be attributed to increased operative and technical skills and intensive care units high potentials, in recent years, surgeons became highly encountered in redo more complex surgically and medically demanding cardiac operations [3]. Despite high progress in surgical techniques and medical strategies, mortality seems higher than primary surgery. Redo cardiac surgery is technically demanding due to scarring of tissues leading to loss of tissue anatomical planes and adhesions increasing the risk of injury during re-entry. It is important to maintain safe and well-planned strategies to prevent such injuries in those patients[4]. Meticulous plans must be considered before surgery to decrease the incidence of re-entry injuries in redo surgeries [5]. CT scan became an important tool in preoperative assessment strategy in redo cases, despite the risk developed to some patients from undergoing CT scan with contrast is small regarding the incidence of contrast-induced nephropathy, severe anaphylactic reaction, and significant renal injury, we performed in all our patients CT chest without contrast and it was sufficient[6].

Authors found a higher incidence of re-entry injury (3.6%) in patients who did not perform a pre-operative CT scan, various structures were identified to be adherent to the sternum in some of those patients. The right ventricle in 68% of the cases was the most common structure found to have adhered to the sternum [7], lack of preoperative imaging was identified as a

predisposing factor for re-entry injury, it is important to determine the accurate location of mediastinal structures concerning sternotomy to reduce the operative risk associated with redo surgery [8]. CPB before sternotomy may be associated with an increase in the CPB time and increased risk of postoperative bleeding but decreasing the risk of re-entry injury, prevention of tissue hypo-perfusion and better myocardial protection should be taken into consideration as the event of fatal hemorrhage during sternotomy re-entry injury, may end catastrophically in absence of pre-sternotomy CPB [9].

Complications of peripheral femoral cannulation are low including local wound complications, distal limb ischemia, pseudoaneurysm, hematoma, and lymphatic leaks. We had a very low risk of complications, only 2 patients had wound superficial infection (2%), and 4 patients had seroma (4%) for which frequent dressing was sufficient for control, then we decided to put a drain in the groin for 2 or 3 days usually, then no more seroma could be identified. Cohn *et al*. reported an incidence rate of 0.7% for arterial complications, 1.5% for venous complications, and 2% for groin infections in cases who performed peripheral femoral cannulation to establish pre-sternotomy CPB[10].

In our study we used a new modification, made the procedure easier and more reproducible, in all 97 redo patients we made a pre sternotomy femoral axis cannulation, we used a PTFE tube graft 8mm to cannulate femoral artery and a metal tip or plastic right-angle venous cannula usually 32 or 34 but down to 28 may be sufficient in small vein size to cannulate the femoral vein and initiate CPB before sternotomy, we maintain the highest flow possible with venous drainage, in most of the cases we were able to maintain near or actual full flow using usual drainage or vacuum-assisted drainage by the perfusionist. Intiation of CPB before sternotomy made the procedure easier with the heart lax and depressurized, we had no re-entry injuries with mandatory pre-operative CT Chest and pre-sternotomy peripheral femoral cannulation, this was matching with other authors who found the incidence of re-entry injury to be reduced by CT scan and lack of re-entry injury if peripheral pre-sternotomy cannulation was performed for CPB [9].

CONCLUSION

We believe that our simple modified technique of pre-operative mandatory CT scan of the chest, and pre-sternotomy peripheral femoral cannulation, and initiation of CPB was very promising in achieving zero re-entry site injury in redo cardiac surgery cases. Our modification by using the metal tip or plastic right-angled venous cannula for peripheral cannulation of femoral vein was a nice tip and trick that was applicable in all our patients to alleviate the need for the standard femoral vein double staged long venous cannula with all its warrants.

Table of abbreviations:

CPB	**Cardiopulmonary Bypass**
CT	**Computed Tomography**
Fig.	**Figure**
PTFE	**Polytetrafluoroethylene**
SD	**Standard Deviation**
CXR	**Chest X Ray**

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