



## A Concept to Make Cardiac Surgery Safer: The Surgeon's Contribution

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### Abstract

The level of safety in cardiac operating rooms is essential to provide the best care. Besides patient-related factors, the outcome involves accurate diagnostic assessment, carrying out a safe surgical strategy, and high-quality team performance. A new approach in the operating room, applying TEE A-View for real-time assessment of the quality of the whole ascending aorta in combination with a short checklist, represents new opportunities for the cardiac surgeon to provide safer operations and better outcomes.

### Introduction

The incidence of adverse events in cardiac surgery, resulting in substantial patient injury, may be four times higher than in all other surgical specialties. More than half is considered preventable and 5.6% leading to death [1]. The complexity of the high technology cardiac operating domain is a contributing factor [2]. Over the last decade, major steps have been set to identify specific factors contributing to adverse events [3]. Initiatives to improve the quality of teamwork like communication, time-out procedures, briefings and debriefings, simulation training, adjustment of the physical environment, and establishing a safety culture have been successfully introduced. Recently, implementation and use of a specific safety check in cardiac surgery resulted in lower postoperative mortality [4]. Acts of medical professionals that undermine a culture of safety, like intimidating and/or disruptive behaviors, are addressed seriously [5].

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The outcome of cardiac surgery is mainly defined in mortality and complication rates. Neurological injury following cardiac surgery is a serious complication, and appears to increase over time in coronary artery bypass grafting [6]. Besides apparent stroke, there is compelling evidence of other detrimental and debilitating neurological effects following successful cardiac operations. Surgeons may be puzzled as to why these events happen and how to undertake actions to prevent this [2]. In this light it should be noted that good surgical outcomes are not necessarily achieved via safe routes. In this Short Communication, we would like to elaborate on a state-of-the-art concept to plan and conduct a safe route for cardiac procedures and offering the opportunity to reduce neurological injury and postoperative mortality.

### Background and Scoop of this Short Communication

The focus in cardiac surgery is to treat its malfunctioning. This may involve coronary arteries, valves, the heart muscle itself, the conducting system or the ascending aorta. Most cardiac operations are undertaken by applying a Heart-Lung Machine (HLM), clamping the ascending aorta and running a cardioplegic solution to the heart. Thus, creating a stable situation for maintaining circulation and oxygenation of the body tissues. For connecting the heart to the hoses of the HLM, cannulas need to be inserted. The distal ascending aorta and the right atrium/inferior caval vein are the most commonly used sites. Clamping the proximal ascending aorta and running a cardioplegic solution to the heart are steps to create a bloodless, immobile operating field to perform the necessary operation. Surgical handbooks focus mainly on operative techniques to deal with a specific cardiac problem. Results are expressed in the way operative success is achieved. However, the contribution of potentially fatal effects of the aortic cannulation procedures of the aorta due to dislodged particles migrating from the inside surface to the brain or elsewhere in the body and the surgeon's role in this particular part of the procedure is underestimated. Visualization of the condition of the ascending aorta, there where the cannula is inserted, should be available to judge potential risks that may necessitate adaptation of the cannulation and clamping procedure in order to achieve a safe starting

point for the best outcome.

### Assessing the condition of the ascending aorta

In earlier times of cardiac surgery, the condition of the wall of the ascending aorta, regarding presence of atherosclerotic plaques, was judged after opening the thorax. Manual palpation of the aorta just before inserting the cannula was the way to do it. For long this raffle remained so because there wasn't another modality. Post-surgery neurological damage was qualified as 'all in the game' of heart surgery. Furthermore, cerebral ischemic effects that were not as outspoken as stroke, for instance reduced span of concentration, subtle changes in personality, behavior, memory and mobility were unnoted or discarded. Nowadays, this method of judging the quality of the ascending aorta has proven to be utterly unreliable. Firstly, only hard plaques can be felt, secondly the extent of the plaque(s) cannot be ascertained correctly and thirdly manipulation itself may dislodge atherosclerotic particles and lastly the presence of soft plaques is overlooked. So manually palpation of the aorta is certainly not the safest way to identify the best cannulation site and is potentially harmful or dangerous. For that reason, the 'no-touch technique' is an adage in every field of surgery. Reliable assessment modalities are now at hand and should be applied within a safety awareness strategy.

Patients scheduled for elective cardiac surgery will have a routine chest X-ray. In Isala, all patients older than 70 years of age also undergo CT-scanning of the thoracic aorta. Furthermore, patients younger than 70 years exhibiting densities of the ascending and/or arcus of the aorta on the chest X-ray or with a history of peripheral atherosclerotic events will also have an additional CT scan of the thoracic aorta. The purpose is to identify calcifications (hard plaques) of the ascending aorta, possibly necessitating adjustment of the cannulation procedure or even abort open-heart surgery. The latter may be the case when a fully calcified ascending aorta (porcelain) is noted and cannulation and clamping the aorta is practically impossible. However, soft plaques are not identified using these modalities. A major disadvantage of these off-line imaging modules is that they are not real-time during surgery and showing only static images. A modality that solves these shortcomings is the use of a Transesophageal Echocardiogram (TEE). Every cardiac patient in our institution will undergo a TEE after being fully sedated and artificially ventilated in the operating theatre. Especially TEE trained cardiothoracic anesthesiologists perform this imaging modality and discuss the findings in a systematic order with the operator, before incision. However, imaging of the ascending aorta is limited to the proximal part, there where the aortic cannula is not inserted. The distal part of the aorta (the 'Blind Spot') cannot be evaluated due to a signal artefact caused by air in the left main bronchus or trachea. When concern is raised about the condition of the proximal aorta, epi-aortic scanning may be followed for the upper part, the distal ascending aorta. Disadvantage of epi-aortic scanning is that the chest and the pericardium need to be opened. When a fully calcified aorta is encountered, abortion of the procedure may be indicated or a drastic conversion of the cannulation method. This may comprise cannulation of the femoral artery, possibly with circulation arrest, implying cooling body temperature to approximately 16 degrees Celsius, arresting circulation and oxygenation in combination with separate perfusion of the cerebral arteries. However, operations requiring circulation arrest, especially in the elderly population, result in increased mortality, significant cerebral damage and long-lasting recovery.

An elegant, safe and rather new method is the TEE 'plus'

modality, TEE A-View, in combination with a short checklist for identifying potential pitfalls to undertake the procedure [4]. TEE A-View is a combination of a regular TEE with a water-filled balloon. After pre-oxygenation of the patient shortly with 100% O<sub>2</sub>, ventilation is stopped and the A-View catheter is positioned through the endotracheal tube, and the balloon is positioned into the trachea and left main bronchus. After positioning, the balloon is filled from outside with sterile saline and resolves the 'blind spot of TEE'. In this fashion, all sites of potential danger like the cannulation site, aortic clamping site, proximal anastomosis site in coronary bypass surgery, the jet outflow track into the aortic arch and cerebral arteries or aortotomy site in aortic valve replacement can be studied in detail [7,8]. Thus, it provides the necessary information of specific areas of the ascending aorta and arch, before incision, for planning a safe cannulation procedure.

### Surgeon's contribution to safer cardiac operations

Over the last decade's patients, eligible for cardiac surgery, got older and experience more comorbidity. Not surprisingly, postoperative mortality and complication rates increase with age, being an independent predictor. The cohort of elderly consuming medical treatment and the costs involved are increasing dramatically. As even technically successful cardiac operations may be followed by detrimental and debilitating neurological effects, every effort should be undertaken to prevent this. Human factors remain at the top of the main causes of preventable medical injury. These facts ask for new competencies of cardiac surgeons. The role of the surgeon as a leader of the OR team has evolved from soloistic technical performer in a 'Hero Culture' to a team player, fully understanding the importance and benefits of the right formula of cooperation, behavior, effective and respectful communication. These soft skills in conjunction with excellent technical skills, built on top-of-the-bill technology like the TEE A-View provide a promising new state-of-the-art concept to accomplish good results, achieved via safe routes. This perfectly fits in the main assignment of every medical professional: Do No Harm. When this safety concept may result in a modified cannulation strategy or even aborting an intended operation, it is to be preferred to operations executed with a definite risk for serious adverse outcome like neurological injury.

In conclusion, we would like to advocate that cardiac surgeons and their team members embrace and incorporate the quintessence of this Short Communication in their daily surgical routine.

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