Peer Review File

This paper is entitled "establishing a robotic coronary artery bypass surgery program – a narrative review."

Comment 1: The abstract should mention some of the data of the literature review and also the essential factors for successful program implementation.

Reply 1: Thank you for this appropriate comment. Based on your suggestion, we added some more information in the abstract regarding a successful program implementation.
In addition, the ideal pathway of a successful trainee for patient selection consists of: a) patient with stable coronary artery disease, b) double vessels disease with a non LAD target that can be treated with stent. C) Robotic CABG LITA to LAD and then stent of the non-LAD territory with angiographic confirmation of LITA to LAD patency. D) Adding a second ITA should be evaluated carefully and after a solid 75/100 cases of single LITA to LAD.

Comment 2: The goal of the review is defined as to provide an overview how to build a successful robotic CABG program. Methods in the abstract mention that the literature was reviewed – was this review done to find the best ways how a program is established? Needs clarification.

Reply 2: Thank you for your comment. We added the following sentence: The literature review was done to evidence the clinical outcomes of already established robotic CABG programs.

Comment 3: The introduction mentions that despite advances in medical management and PCI there is a need for developing robotic CABG. The objectives of the manuscript are then repeated.

The section TECAB vs MIDCAB outlines the differences between the procedures. It is stated that TECAB would offer more options for multivessel revascularization. In that paragraph an accountability sentence appears which should probably go into the methods section.

Reply 3: Thank you for your suggestion. We rephrased the sentence: One of the main benefits of TECAB consists of the possibility of serving multiple coronary territories, including the lateral wall and sequential diagonal grafting.

In the methods section the approach to literature search is outlined. Inclusion criteria included CABG patients with (robotic ?) MIDCAB and TECAB.

Comments 4: Results – 46 studies were found including 9228 patients. Survival rates are presented but it needs to be defined whether this is periprocedural survival or survival at a certain timepoint thereafter. I also suggest to mention some of the methods and results in the abstract.

Reply 4: Thank you for this important comment. We now clarified that the outcomes are up to 30 days post intervention. In addition, we added the following sentence in the abstract: In addition, literature review found 46 studies and 9228 patients were included.

Comment 5: For an outline of the learning curve an eight-step approach according to Balkhy et al. is suggested. I agree with this approach in principle it could, however, be pointed out more specifically that simulation in dry-lab and wetlab models is also very important. Schachner's paper which defined six elements of the TECAB procedure which can be taught to trainees. Also a STS database analysis covering 5 years and robotic MIDCAB performed by 114 surgeons is cited. 10 cases were defined as the basic learning curve. Is there a corresponding number for TECAB?

Reply 5: Based on your comments we specified in the text that simulation in dry-lab and wetlab models is also very important. With respect to the number of TECAB for the basic learning curve Patrick et al. (1) JCTVS report that the learning curve for procedural success is overcome by the 10th case, even though the curve for reoperation is still steep by the 25th case.

Comment 6. Patient selection is a next section. Several patient subgroups are mentioned which are suited for robotic CABG. Some important contraindications are listed. Cardiopulmonary bypass is mentioned and the importance of a CT angio is pointed out. A note on when CPB should be used could be added. The paragraph on high and low risk patients should probably clearly state that at the start of a robotic program high risk patients should be avoided.

Reply 6: Dear reviewer. Thank you for your comments. Based on your comment, we added a sentence stating that at the start of a robotic program high risk patients should be avoided. We also mentioned the indications on when to use CPB.

Comment 7: A stepwise approach is suggested for successful implementation of a robotic CABG program. The Donabedian triad is presented as the method that was used at the author's institution. In this triad evaluation of the entire health care delivery process is important. Team simulations are carried out at all phases of patient care. Two papers are cited which present procedure steps to be taken towards a totally endoscopic CABG procedure. The authors suggest that experience level of anesthesia and perfusion are important factors as well as communication within the team using Bluetooth technology. Team training is again pointed out and it is regarded as important that all team members have training in the procedure elements at least in cadavers or animals. This increases the understanding of a complex procedure. Positive interaction between surgeon, department leadership, and hospital administration is presented as a key factor for successful program implementation.

In the experience of the author's institution the costs of robotics are outweighed by the benefits of shorter hospital stay. Are there other studies showing this? If yes, please cite.

Reply 7: Thank you for your comment. With respect to the robotic CABG costs, please see reference 2.

Comment 8: A section on program promotion follows. The importance of data collection is pointed out. Concerning advertisement and marketing a cautious approach is recommended. Continuous training of the surgeon is also highlighted.

In the paragraph "benefits of robotic-assisted MIDCAB and TECAB" several papers demonstrating advantages are presented and cited. It may be worthwhile mentioning that currently no prospective randomized trial is available.

Reply 8: Dear reviewer. We added the following sentence: however, there is a need for call of clinical trials that investigates the current evidence gap for robotic CABG and hybrid revascularization.

Comment 9: A section follows in which the current lack of an endostabilizer for TECAB is pointed out. Several uses of this device are mentioned.

Future perspectives talk again about a stepwise approach for trainees to achieve clinical robotic skills. Drylab and wetlab training is pointed out.

"Discussion" – repeats the main important factors for successful program implementation. A stepwise approach is again highlighted.

The conclusion also points out the stepwise approach.

Figures: In figure three I would avoid adding an advertisement for an institution or surgeon

Reply 9: Dear reviewer. We removed the surgeon photo from the figure.

Comment 10: Figure 6 is interesting but should be better explained in the text

Reply 10: Dear reviewer. We added the following sentence: In this context, the majority of the centers perform 1-5 cases per year while there are only a few centers that perform more than 10 cases per year.

Comment 11: Figure 7 – is interesting

Table 1 – unclear if survival is perioperative or long-term. Needs to be clarified

Reply 11: Please see above the clarification on this topic.

Comment 12: Some English corrections are necessary.

Reply 12: The manuscript was reviewed by a native speaker.

Thank you

References

1)   Patrick WL, Iyengar A, Han JJ et al. The Learning Curve of Robotic Coronary Arterial Bypass Surgery: A Report from The STS Database. Journal of Cardiac Surgery. 2021 Aug.
2)   Leyvi G, Schechter CB, Sehgal S, et al. Comparison of Index Hospitalization Costs Between Robotic CABG and Conventional CABG: Implications for Hybrid Coronary Revascularization. JCVA. 2016 Jan;30(1):12-8.

Reviewer 2

Comment 1: Excellent narrative review following a very structured method on how to build up a robotic program.

Reply 1: We thank the reviewer for this comment.

Comment 2: Line 111-... "that with TECAB there is the huge advantage to been able to serve more coronary territories than with Robotic MIDCAB. In addition, these includes the lateral wall and sequential diagonal grafting."

This statement is not completely true since we all know that nowadays it is possible to do complete revascularisation through a thoracotomy. I would recommend to soften the statement.

Reply 2: We corrected the sentence as follows: . One of the main benefits of TECAB consists of the possibility of serving multiple coronary territories, including the lateral wall and sequential diagonal grafting

Reviewer 3

The authors present a very important paper sharing practical tips in how to start a high-volume robotic CABG program. As the authors discuss, the uptake of robotic CABG in North America has been slow. Below are my comments.

Comments and questions:

Comment 1. Does having a robotic program help with the learning curve of the trainee with better visualization of surgical field and ease to stimulate the surgery? If there is, consider expanding this in the paper.

Reply 1: Thank you for your comment. We added the following sentences: Resident training is also fundamental to the development and spreading of robotic programs. In the last years robotic CABG education has change from being mainly vendor facilitated to a current training condition with minimal direct vendor interaction. After initial robotic cardiac training consensus recommendations, vendor-based training role has diminished, and the application of robotic CABG has evolved. In this context, a better visualization of surgical field and ease to stimulate the

surgery have increased the trainee capability to have a 360-degree overview and control of the operation.

Comment 2. Consider elaborating on what has been the main hurdle for broader adaption of robotic assisted minimally invasive surgery and how to overcome the hurdle.

Reply 2: Thank you for your comment. We added the following sentences: Current limitations of the spreading of robotic CABG programs include the perceived high costs and the limited training available programs. In this context, the index hospitalization costs of robotically assisted CABG is similar to the conventional CABG (71).

Comment 3. Consider the importance of heart team approach and discussing how the cases are discussed with interventional cardiologists at your institution. Hybrid revascularization likely benefits those with intermediate to high SYNTAX score, and heart team approach with detailed evaluation of risk and benefit of each modality (open CABG, hybrid revascularization, multivessel PCI, OMT) will be necessary in this population.

Reply 3: Dear reviewer: Thank you for your comment. We added the following sentence to the paragraph.

In our center, patients candidates for either robotic CABG or coronary intervention are discussed on medical rounds together with the heart-team including cardiac surgeons, interventional cardiologists and anesthesiologists. Based on the risk profile and suitable anatomy, the patient is considered a candidate for either robotic CABG, hybrid revascularization or PCI.

Comment 4. The authors recommend the open CABG for patients with chronic total occlusion. Depending on the expertise of the interventional cardiologist, hybrid revascularization can also be considered in this population (1).

Reply 4: Thank you for your valuable comment. We added the following sentence.
However, depending on the expertise of the interventional cardiologist, hybrid revascularization can also be an option in this group of patients.

Comment 5. Please consider discussing the future directions and the current evidence gap for robotic CABG and hybrid revascularization.

Reply 5: Dear reviewer: Thank you for your comment. We added the following comments:
Current limitations of the spreading of robotic CABG programs include the perceived high costs and the limited training available programs. In this context, the index hospitalization costs of robotically assisted CABG is similar to the conventional CABG (71).

With respect to future perspectives, please refer to paragraph 10.

Reference

1. Hirai T, Kitahara H, Balkhy HH, Blair JEA. Advanced hybrid complete revascularization with TECAB and Impella-assisted PCI of CTO. Cardiovasc Revasc Med 2019.

Editorial Comments

Comment 1: Please clarify why there is a need for the focus on survival outcome of MIDCAB and TECAB, not other outcomes, such as the postoperative pain, quality of life etc.

Reply 1: Thank you for this excellent comment. Robotic CABG survival rate has been long debated due to its complexity and the required high skill levels of reproducibility. Therefore, we think that survival outcomes of MIDCAB and TECAB deserve a special mentioning on this review. On the other hand, only some studies have previously reported the outcomes of quality of life and postoperative pain. Therefore, we focused our attention on the survival rate after robotic CABG. We have added the following at the limitation paragraph.

Reply1: Robotic CABG survival rate has been long debated due to its complexity and the required high skill levels of reproducibility. Therefore, we think that survival outcomes of MIDCAB and TECAB deserve a special mentioning on this review. On the other hand, only some studies have previously reported the outcomes of quality of life and postoperative pain. Therefore, we focused our attention on the survival rate after robotic CABG.

Comment 2: Page 22, "9.0 Future perspectives", I suggest adding more comments describing more team training methods and highlight the rationale for focusing on it, since learning curve has significant implications for patients' clinical outcomes.

Reply 2: Thank you for this important suggestion. We have added the following description. ''It is recommended that trainees develop essential instrumental skills including a robust method of instrument position and use. Two clinical studies (69,70) have proven that intensive and console training in performing incision and knot tie reduces the time to perform the procedure as well as the number of errors. Console instrumental skills are important to be developed in a mentored situational environment first in a drylab and further in a wetlab. Further training advancement can be acquired on the patient bedside as an assistant during the surgical procedure. This includes the port access incision and port position. The next step consists in the acquirement of spatial awareness (understanding the location of organs and structures) as well as the ability to translate the hands movements on the robotic arm movements are crucial. Additional important features include tissues handling, cauterization of the tissues, sawing, and acute bleeding management. It is also important to understand the timing and necessity of full sternotomy conversion in patient life-threating situations. During the training process in the operating room the trainee should begin by performing the simplest part of the procedure and progressively increasing difficult maneuvers as the mentor sees fit.''

 Comment 3: Besides, the authors have reported the detailed exclusion criteria (case reports, reviews, articles not in English, studies after 2008 when robotic procedures reports began to be published). The authors are suggested to report the details of inclusion criteria, such as disease/condition definition.

Reply 3: Thank you for this comment. We added the following sentence to the inclusion criteria: 1) patient with coronary artery disease undergoing CABG with MIDCAB or TECAB.