Additional right-sided upper “Half-Mini-Thoracotomy” for aortocoronary bypass grafting during minimally invasive multivessel revascularization

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Abstract

**Background:** Although minimally invasive coronary artery bypass grafting (MICS-CABG) has been shown to result in excellent clinical outcomes overall adoption rates still remain low. Traditional strategies for minimally invasive multivessel revascularization - usually performed through single-thoracotomy – have to deal with restricted grafting possibilities and possible increased susceptibility of arterial grafts to competitive flow, restraining their applicability to very specific indications or hybrid approaches and on top, are prone to conversion to full-sternotomy in case of left internal thoracic artery (LITA) insufficiency.

**Methods:** Here, we present a novel alternative to the traditional MICS-CABG approaches by adding a right-sided upper “half-mini-thoracotomy”, which allows for aortocoronary bypass grafting in standard “off-pump” manner and adoption of similar revascularization principles as with conventional CABG during minimally invasive multivessel revascularization, though reducing restrictions inherent to current MICS-CABG strategies.

**Results:** So far, feasibility and safety of this new approach has been successfully shown in 7 consecutive patients requiring surgical revascularization with no procedure-specific complications and graft configuration as well as intraoperative flow assessment comparable to those of similar patients operated via standard full-sternotomy off-pump coronary artery bypass (OPCAB) surgery.

**Conclusions:** Further evaluation warranted, this technique might have the potential to develop into an additional approach for minimally invasive multivessel revascularization, especially in cases where competitive flow to arterial grafts is feared, while also serving as a bailout-strategy for traditional approaches in case of LITA insufficiency.

**Keywords:** Coronary artery bypass grafting (CABG), Off-pump coronary artery bypass grafting (OPCAB), Minimally invasive coronary artery bypass grafting (MICS-CABG), Minimally invasive surgery, New surgical technique

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**Background**

Despite the increasing numbers of percutaneous interventions, coronary artery bypass grafting (CABG) still remains the gold standard for the treatment of multivessel coronary artery disease in many patients. However, although clinical outcomes have dramatically improved since first introduction of CABG five decades ago, invasiveness of the procedure has not significantly changed, with most of the routinely performed CABG procedures still involving full-sternotomy and aortic clamping [1]. Although minimally invasive coronary artery bypass grafting (MICS-CABG) alternatives have been widely explored showing excellent clinical outcomes overall adoption rates still remain low.

Traditional strategies for minimally invasive multivessel revascularization are of high technical complexity - usually performed through a single-thoracotomy - and have to deal with restricted grafting possibilities and subsequent possible increased susceptibility of arterial grafts to competitive flow, restraining their applicability to very specific indications or hybrid approaches. On
to the target secondary vessel(s) are used, with a mean of 2.14 ± 0.35 distal anastomoses per patient (LAD, n = 7 (100 %); RCX marginal branch, n = 7 (100 %); RCA branch, n = 1 (14.3 %)). Proximal aortic anastomoses were handsewn via HeartString™ device in all 7 patients (100 %), while in one of the patients additional intraoperative proximal anastomoses revision via partial aortic clamping was necessary due to excessive graft length (14.3 %). In 5 of the patients (71.4 %) CPB via femoral cannulation was used for aortocoronary bypass grafting, mainly due to safety issues concerning the learning curve of implementing a new technique. Conversion rate to sternotomy was 0 % for all cases. All 7 patients (100 %) underwent complete revascularization (defined as revascularization of each major myocardial territory subtended by a coronary artery of 1.5 mm or more in diameter with stenosis ≥ 70 %) with no procedure-specific complications. In all patients, macroscopic anastomosis quality, graft configuration and intraoperative flow assessment were comparable to those of similar patients operated via standard full-sternotomy off-pump coronary artery bypass (OPCAB) surgery. Further, patient satisfaction at discharge in terms of having being able to avoid full-sternotomy, was particular high.

Discussion

Evolving surgical strategies, such as OPCAB and MICS, are specifically developed to improve short- and long-term outcomes and to reduce the level of invasiveness of CABG. However, although prone to be beneficial for the patients in terms of reduced rates of transfusion and wound-infection as well as enhanced recovery to full activity and greater patient acceptance [3], overall adoption rates of MICS-CABG approaches remain low.
[1]. Usually performed through single-thoracotomy or port-access based they are either restrained to specific indications or hybrid approaches because of restricted grafting possibilities (MIDCAB), have to deal with increased susceptibility of arterial grafts to competitive flow [4] (MVST), need specialized infrastructure and training (totally endoscopic coronary artery bypass - TECAB) and are usually prone to conversion to full-sternotomy in case of LITA insufficiency.

Although, minimally invasive multivessel revascularization with aortocoronary bypass grafting performed through single-thoracotomy [5] is possible and has been shown to result in excellent clinical outcomes [6] as well as angiographic graft patency [7] adoption rates remain low. Here, the technical complexity - demanding intricate exposure maneuvers to anastomose grafts onto the ascending aorta while being highly dependent on favorable patient anatomy – is probably one of the major concerns in surgeons not experienced with this approach, restraining the applicability of MICS-CABG surgery to a small number of surgeons and patients.

As demonstrated in this report, an additional right-sided upper “half-mini-thoracotomy” can be an easy to adopt alternative to current MICS-CABG approaches, allowing for aortocoronary bypass grafting in standard OPCAB manner and liberal adoption of similar revascularization principles as with conventional CABG. Although this means having an additional “small scar” on the upper right thorax, patients can hereby potentially be spared a full-sternotomy without need to compromise in the number of employed grafts.

**Conclusion**

Further evaluation warranted, this technique might have the potential to develop into an additional approach for minimally invasive multivessel revascularization, especially in cases where competitive flow to arterial grafts is feared, while also serving as a bailout-strategy for traditional approaches in case of LITA insufficiency.

**Abbreviations**

CABG: Coronary artery bypass grafting; CPB: Cardiopulmonary bypass; LAD: Left anterior descending coronary artery; LITA: Left internal thoracic
artery; MICS: Minimally invasive cardiac surgery; MICS-CABG: Minimally invasive coronary artery bypass grafting; MIDCAB: Minimally invasive direct coronary artery bypass; MVST: Multivessel small thoracotomy; OPCAB: Off-pump coronary artery bypass; RCA: Right coronary artery; RCX: Circumflex coronary artery LAD; SV: Saphenous vein; TECAB: Totally endoscopic coronary artery bypass.

Competing interests
The authors declare that they have no competing interests.

Authors' contributions
HA and AA developed and performed the presented surgical technique and collected the data. PA and AL made substantial conceptual contributions and helped drafting and revising the manuscript. All authors read and approved the final manuscript.

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