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Short Commentary

Rhetoric Questions for Surgeons in the Transcatheter Edge- to- Edge Repair and Artificial Intelligence Era

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Introduction

The advancement in minimally invasive approach via a transcatheter route for dealing with valvular regurgitation has been exponential the last decade. State of the art devices and complex algorithms produced utilising artificial intelligence technologies dominating our life and will be the near future direction of modern healthcare systems. The evolving technique of edge- to- edge repair for the management of secondary Mitral Regurgitation (MR) has revealed contradictory results in the past as it has been depicted in two major clinical trials which sparked major debates [1,2]. The 5- year data of the COAPT trial [3] published last year shows survival benefit for the patients but despite this profound benefit, the mortality and the hospitalisation rate remains high in this cohort of patients. The advancement in artificial intelligence technology and the progress of regenerative medicine may constitute the mean on the effort of developing new therapeutical techniques for the complex secondary mitral regurgitation.

Trial Analysis

Unarguably, the 5- year data of the COAPT trial demonstrates the beneficial effect of the edge-to-edge repair by decreasing the rate of death and hospitalisation related to heart failure when compared to medical therapy alone in the control group. However, if we carefully examine the objective indexes of the Left Ventricular function (LV) which consist of the left ventricular chamber size and function, forward stroke volume, cardiac output and right ventricular systolic pressure, these parameters haven't changed- in fact they are similar between the 2 groups during this 5 year follow up period.

A careful look on the holistic elements synthetising the mitral valve function, reveals the following based on the published results:

1. The left ventricular end diastolic and end systolic volume was decreased in the 5-year follow up period in the device group. The same occurred in the optimal medical therapy group. It is not clear whether this is related to reduction of the severity of mitral regurgitation, the optimal medical therapy or the fact that more than 50% of patients in the control group had been treated with percutaneous edge- to- edge repair within the 5-year period.

2. The left ventricular end- diastolic dimension marginally decreased in both groups. Similarly, the left ventricular end-systolic dimension remained almost unchanged in both groups. In essence, these important echocardiographic indexes are unchanged between the two groups. Hence, it remains ambiguous the role of reduced MR by decreasing only the orifice area and leaving unaddressed the other important elements of the left ventricular function.

3. The left ventricular ejection fraction was decreased in the device group and slightly increased in the control group.

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This is expected to a certain extent shortly after correcting the MR given the increment of the LV afterload. Notwithstanding, it remains evasive the role of the device alone to reverse the remodelling of the LV- 5 years post MR reduction.

4. The right ventricular systolic pressure decreased, as expected, in the device group as it occurred in control group too. Could that be related to the crossover of the patients between the 2 groups given the fact that the abovementioned parameters of reverse remodelling were little or not changed?

5. The cardiac output and the forward stroke volume were marginally better in both groups, even though, most of the patients at the 5-year follow up having only none or 1+ grade of MR. Would there be a rationalised explanation for this finding?

Discussion

These 5 years follow up data, demonstrate that the transcatheter edge- to- edge repair has a survival benefit for patients with secondary MR when compared to the medical treatment alone. Besides that, the 5-year mortality and hospitalisation rate remain high (73.6%) despite the crossover of the patients from the control group. Based on the above results, rhetoric questions are arising for surgeons who may think to revisit their future approach to the complex medical entity of functional mitral regurgitation.

Should a surgical strategy be redesigned for the surgical treatment of secondary MR which is undoubtedly more complex than the primary? The harmonised function of left atrium, mitral valve annulus along with the leaflets, the sub valvular apparatus and the left ventricle per se, results in a competent mitral valve and a well-functioning left ventricle.

Should cardiac surgeons revisit their view on operating in secondary MR by addressing carefully all the 5 elements?

Should the heart team carefully examine the role of right ventricular function, tricuspid valve function and pulmonary artery pressures with possible reversibility when treating secondary MR?

Should the edge-to-edge repair be reserved for patients deemed inoperable with highly predicted mortality according to the current surgical scores?

Should the transcatheter edge-to-edge repair be utilised as a bridge to surgery until favourable left and right ventricular remodelling occurs?

AI Perspective

Given the rapid technologic advancement and the use of AI technologies such as machine learning, natural language processing, artificial neural networks and computer vision in the modern healthcare setting another set of question arises. What is the role of AI in this type of valvular disease? Could AI augment surgeon's cognitive abilities to facilitate the understanding of complex pathologies and navigate safe, efficient and successful surgical treatment? [4]. To get the right answers from AI based technologies the right questions should be answered using the right dataset which will produce ultimately accurate and trustworthy results. All the above mentioned highly sophisticated techniques are now well embedded in the surgical field [5]. Invaluable answers can be gained to the above questions by creating complex algorithms to predict the outcome of each intervention, specify the appropriate intervention based on the particular valvular disease, predict mortality, complications, repair failures, hospital stay and myriad other parameters. The utilisation of radiomics in imaging of the bi-ventricular function has already been in practice in cardiology and radiology settings [6] and it could assist to categorise the patients in the repair, replacement or transcatheter group taking into consideration relevant preoperative data based on previous produced algorithms. AI created algorithms using data derived from bi-ventricular function parameters, tricuspid valve function and pulmonary circulation pressures values could assist the heart team in decision making and drawing the subsequent operative plan. Unarguably, revolution of human -machine interaction is ahead of us, and cardiac surgeons should embrace and adopt these technological advancements as the future of surgery is hybrid with automated robots outperforming humans [7]. New collaborations between data scientists, engineers and health care professionals are of paramount and its role its obviously synergistic in designing the new landscape of training for the surgical field.

Future Directions

The field of regenerative medicine is exciting and certainly will play vital role in the treatment of several diseases including cardiovascular pathologies. Stem cells transplantation has been used for years with promising results [8]. The predictive modelling could help identify patterns and associations to predict outcomes of the functional MR repair post subsequent STEM cell transplantation, develop algorithms for treatment strategies and find the most suitable scaffold fabrications method to identify the best delivery method and site of transplantation [9]. With the help of niche technology from the AI and regenerative medicine fields, the treatment of secondary mitral regurgitation may be again a surgical target.

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