A novel approach to ischemic mitral regurgitation (IMR)

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Introduction

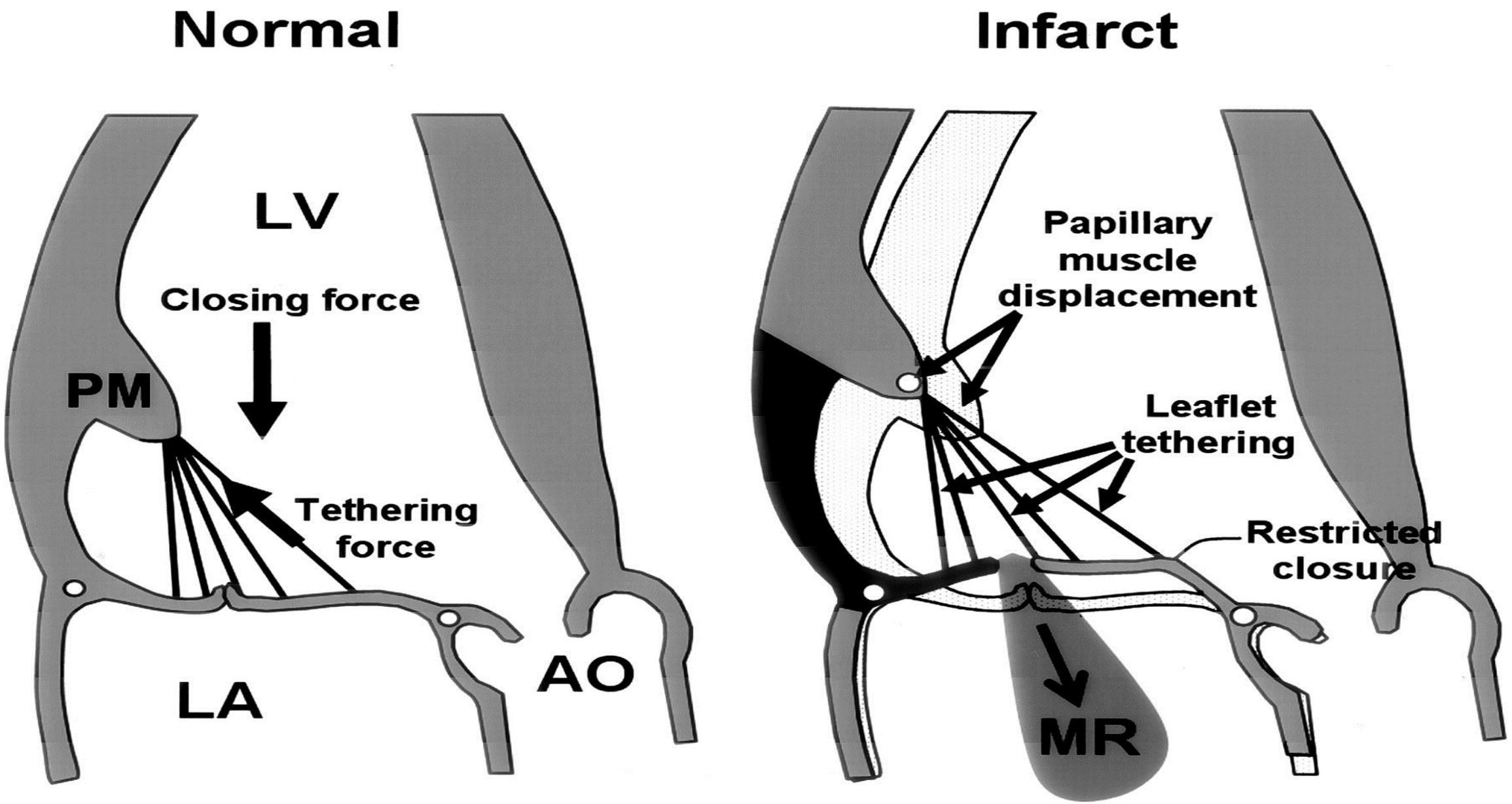
Ischemic mitral regurgitation (IMR) is a complicated medical condition with varying degrees of coronary artery disease (CAD) and mitral regurgitation (MR).

The MR results from ventricular changes induced by myocardial ischemia and/or infarcts.

Ventricular remodeling with posterior displacement of the medial papillary muscle generally causes regurgitation.

That displacement then leads to restriction of the posterior leaflet and an **anteriorly directed regurgitant jet.**

In some cases, **annular dilation** from ventricular enlargement can result in MR with a resultant **central jet**.


Normal
LV
Closing force
PM
Tethering force
LA
AO
Infarct
Papillary muscle displacement
Leaflet tethering
Restricted closure
MR

Introduction

Under current guidelines, coronary revascularization is a the mainstay of treatment for this disease; ***but many questions still surround the best approach to the mitral valve*** .

Although most agree ***that severe IMR requires surgical intervention***, the issues of repair versus replacement, as well as necessity of mitral surgery for lesser levels of regurgitation, remain controversial.

In January 2014, a study funded by the National Institute of Health and published in the New England Journal of Medicine ***found no difference in clinical outcomes between mitral valve repair and mitral valve replacement (MVR) for severe IMR***, although a more lasting correction of MR was noted in the replacement group .

In December 2014, a study investigating the addition of MVR to coronary artery bypass grafting (CABG) in patients with moderate IMR ***failed to show a meaningful clinical improvement in the patients who underwent mitral repair .***

Revascularization approaches

Coronary revascularization is fundamental to treating IMR.

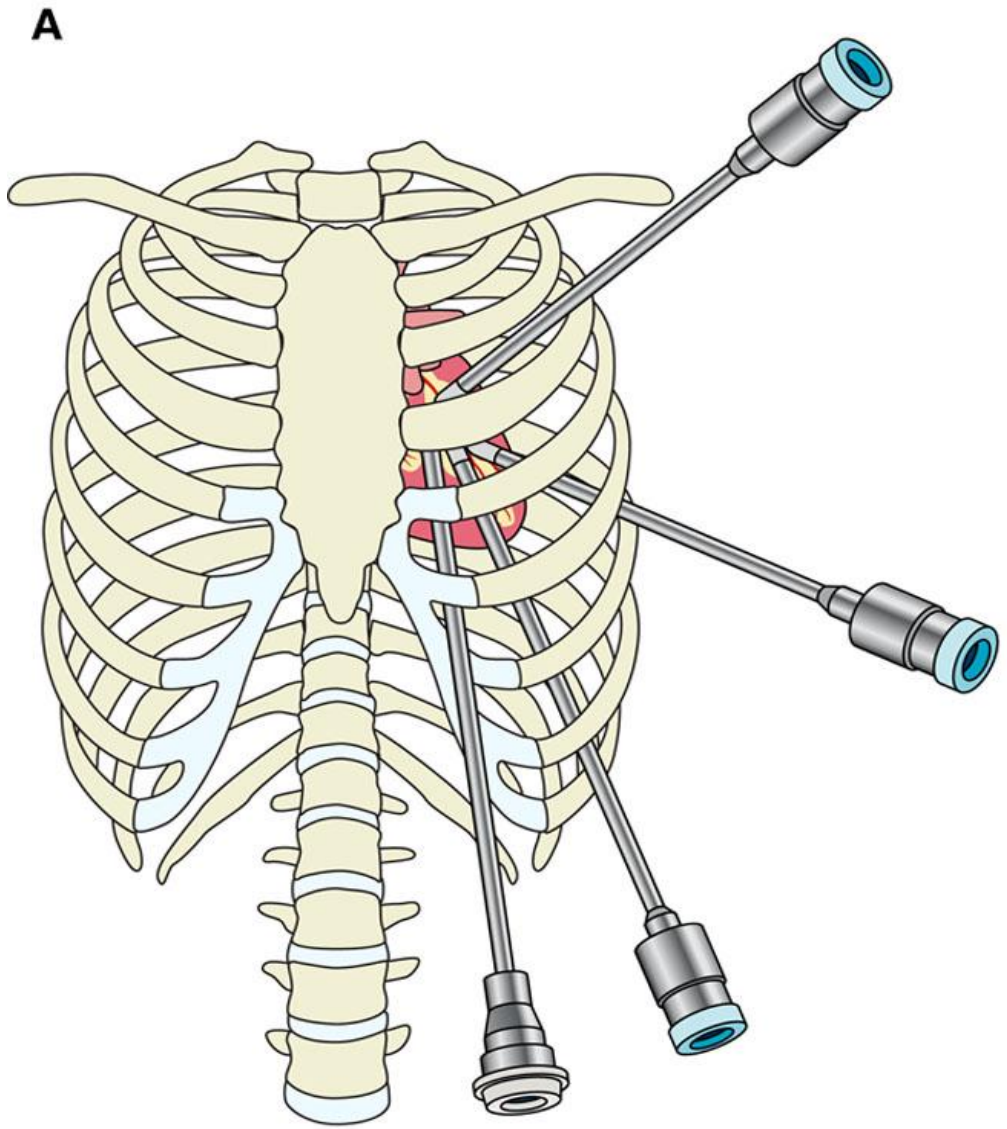
Three distinct approaches exist that can be distinguished **based on level of invasiveness**.

The **first** is traditional CABG via a median sternotomy.

The **second** is minimally invasive coronary artery bypass grafting (MIDCAB) with or without the use of robot assistance via the left anterior chest.

A more feasible practice would consist of a minimally invasive left internal mammary artery (LIMA) to left anterior descending (LAD) coronary artery anastomosis combined with percutaneous coronary intervention to the non-LAD territories requiring revascularization, Hybrid Coronary Revascularization (**HCR**).

The **third** option is multi-vessel PCI alone.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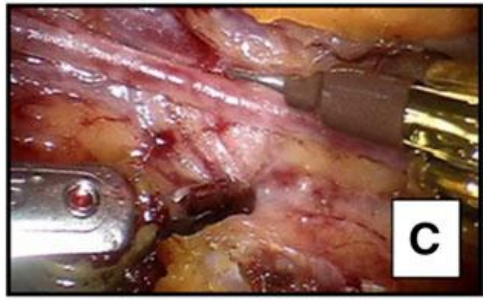
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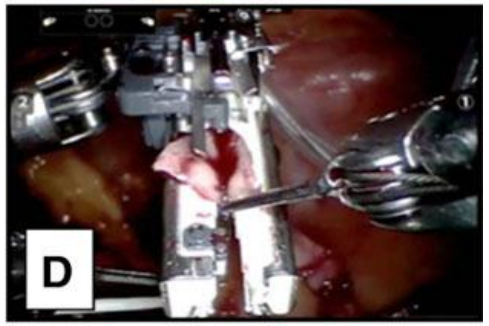
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Revascularization approaches

PCI is the least invasive method of coronary revascularization; and while it has short-term morbidity advantages over traditional bypass surgery, it has not been able to meet the long-term benefits in mortality and freedom from revascularization that CABG provides in patients with multi-vessel disease.

Fortunately, in-stent restenosis, one of the major limitations of percutaneous revascularization, has decreased with each new generation of coronary stent.

PCI, however, has yet to match CABG with regard to long-term benefits .

Multiple studies have consistently demonstrated that for patients with ***multi-vessel disease and/or left main disease***, regardless of the presence of diabetes, CABG yields better outcomes than PCI in terms of mortality, myocardial infarction and need for repeat coronary revascularization .

Revascularization approaches

Even when comparing CABG versus PCI for patients with ***proximal LAD disease***, Hannan et al., showed that CABG patients had lower rates of repeat revascularization.

The benefit of CABG over PCI involves the long-term effects of **IMA to LAD anastomosis**.

On the other hand, **PCI offers** significantly lower rates of morbidity, including stroke, renal failure and shorter hospital stay.

HCR is a revascularization strategy that attempts to combine the advantages of CABG and PCI.

The LIMA to LAD anastomosis is done ***off-pump*** through a small left anterior thoracotomy, thereby eliminating aortic manipulation and the need for cardiopulmonary bypass, both of which increase the risk of procedural complications, including stroke, while providing the long-term benefit of IMA.

PCI can be employed to resolve significant ***non-LAD*** coronary lesions.

Recent studies on HCR have demonstrated that the results of this method are equivalent to the benefits of open CABG along with the morbidity advantages of PCI.

Revascularization approaches

Halkos et al. reviewed **300 patients** who underwent HCR over a 9-year period.

Their cohort had a 1.3% mortality rate, 1% stroke rate, 4.8% need for repeat revascularization and a 96% LIMA patency rate.

These results are comparable to traditional CABG with a potentially decreased rate of stroke.

In addition, Harskamp et al. compared HCR to CABG in a propensity-matched analysis in over 1,000 patients over 10 years.

Their study **demonstrated similar mortality between HCR and CABG , *but HCR was associated with a significantly lower rate of hospital morbidity***, including renal failure, prolonged ventilation, infection, transfusions and shorter hospital stays .

Mitral regurgitation (MR) approaches

For patients with MR and an indication for intervention, treatment options can also be distinguished, ***based on level of invasiveness, into three categories***.

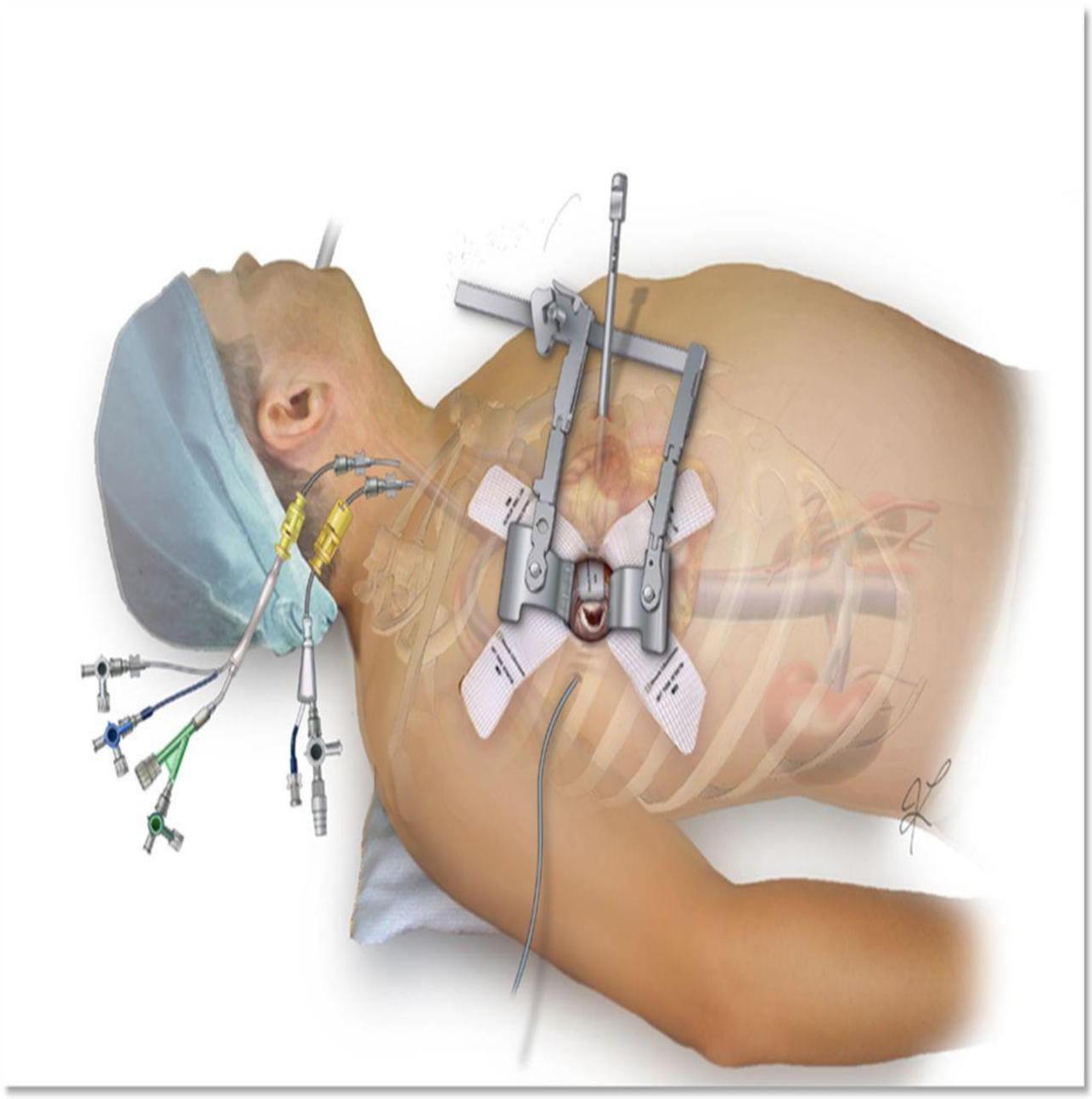
MVR has traditionally been performed **through a median sternotomy with cardiopulmonary bypass** and exposure of the mitral apparatus through Sondergaard's groove, the inter-atrial septum or less commonly the dome of the left atrium.

The **minimally invasive** mitral operation (mini-MVR), via the right chest, is a second option.

Finally, a percutaneous edgeto-edge repair of the mitral valve **(PEER), simulating an Alfieri stitch,** is possible**.**

The data suggest that outcomes, including **long-term survival of patients undergoing mini-MVR, are comparable to MVR.**

Another option, PEER, specifically involving malcoaptation of the anterior and posterior leaflets, now exists as a feasible treatment option for MR.

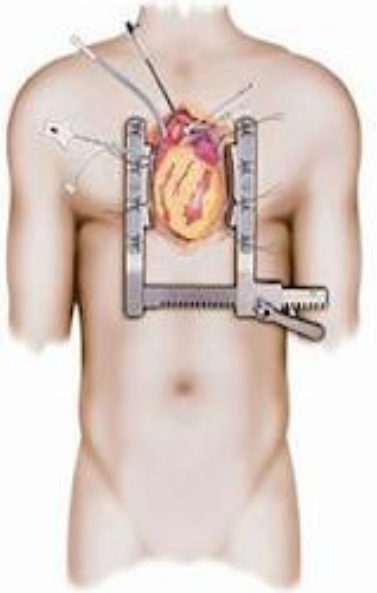


A

Minimally invasive heart surgery
(small incision, no bone cutting, less tissue trauma)

B

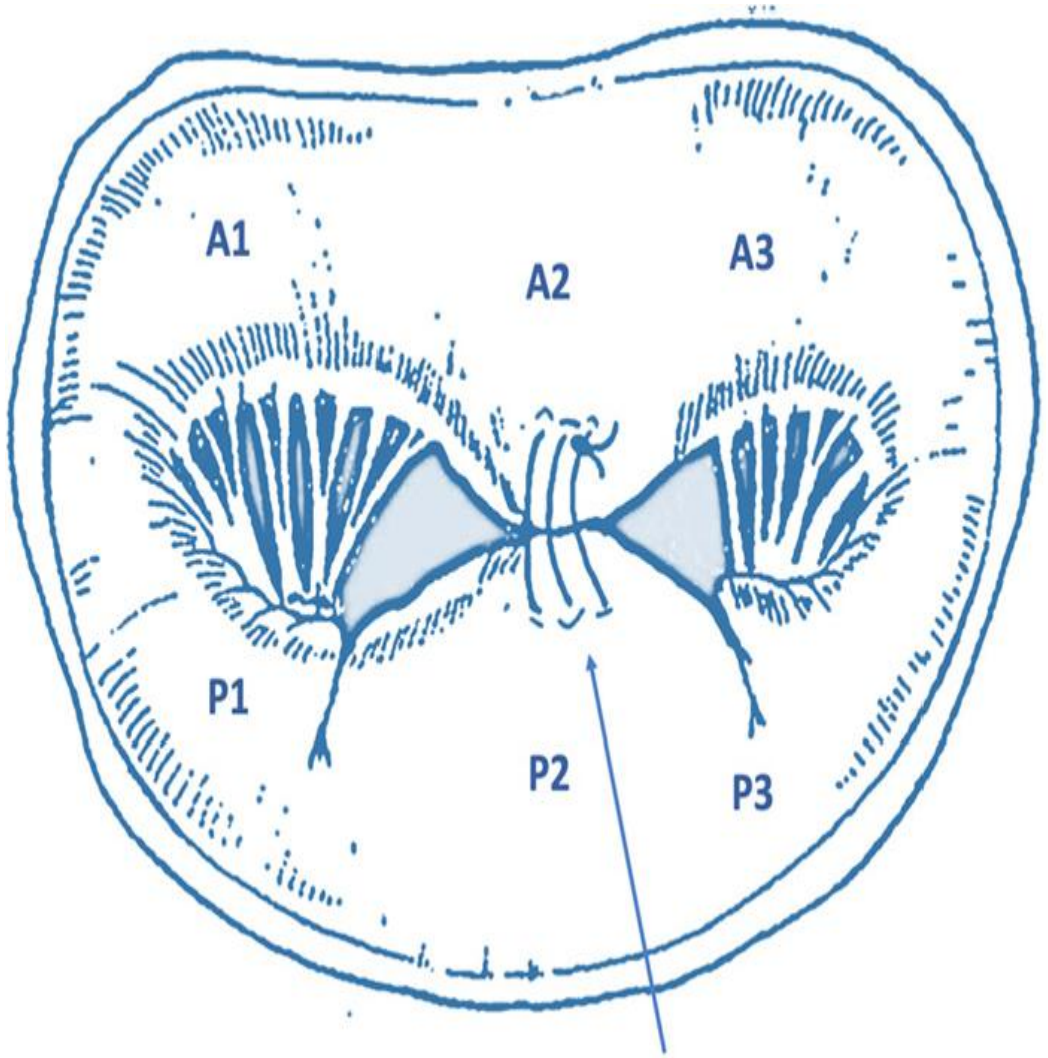
Conventional open heart surgery
(sternotomy, breastbone splitting)



A

B

PEER involves percutaneous venous access, puncture through the interatrial septum, and deployment of a clip to secure the edges of the mitral leaflets and decrease or eliminate the regurgitant jet.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A2
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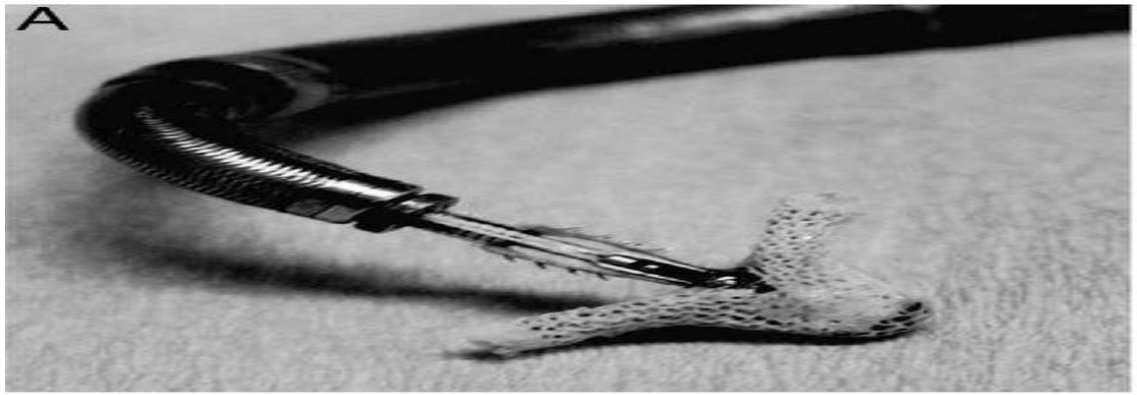
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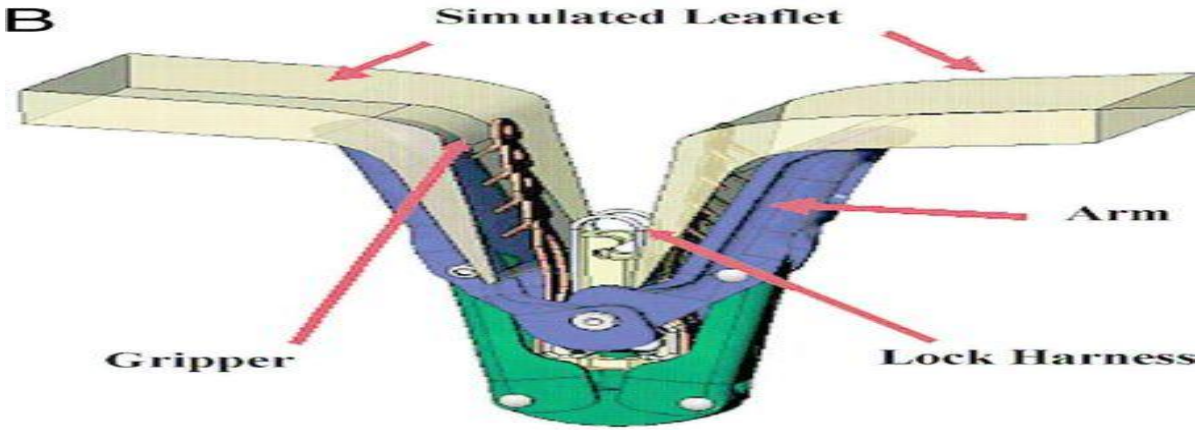
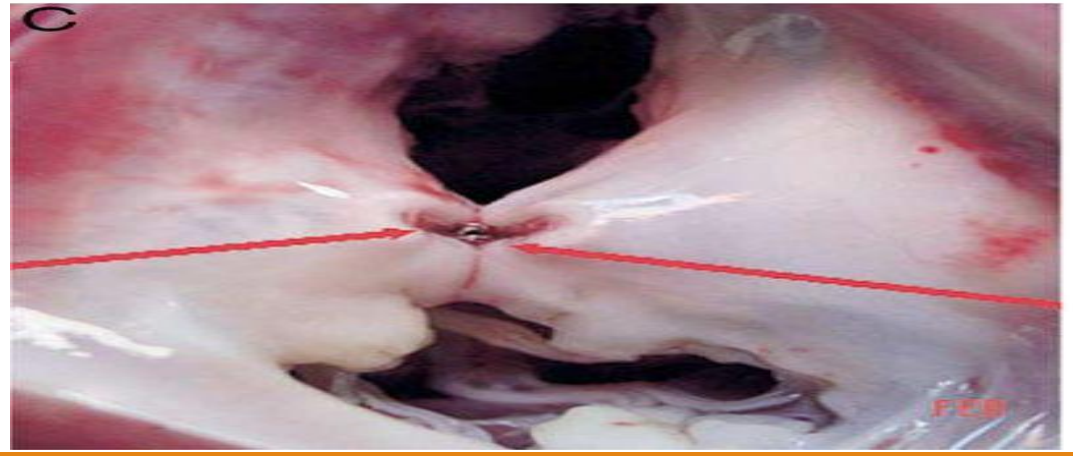

B
Simulated Leaflet
Arm
Gripper
Lock Harness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Mitral regurgitation (MR) approaches

In 2011, the initial **EVEREST II** data was published , This study randomized patients with **3-4+ MR** into **traditional MVR and PEER** approaches and compared outcomes up to one year after intervention.

While patients in the PEER cohort had significantly fewer major adverse events at 30 days, a significant portion ultimately required MVR, thus failing to meet equivalence with regard to efficacy.

Taken together, these sources suggest that while PEER may be a ***less attractive treatment option for most MR patients***, it may yet find a niche within the previously described high-risk group and may provide another alternative for treating IMR.

IMR is an important disease process and therapy has focused on ***both revascularization and repair or replacement of the mitral valve*** for at least those with severe MR.

CABG + MVR— is the current standard of care.

The remaining six have various attributes that could make them relevant to subsets of IMR patients for whom the current standard of care falls short or could be improved

CABG + PEER

At face value, it would seem counterintuitive for a patient to undergo the most invasive treatment option for coronary revascularization and the least invasive approach to treating his or her MR.

Several arguments for this approach can nonetheless be made.

Cardiopulmonary bypass and aortic cross clamping could be eliminated if the CABG was performed off-pump.

Furthermore, the PEER device could be placed directly through the left or right atrium, or potentially through the left ventricle—though this would require modification of the current device—simplifying the technical procedure.

This could be beneficial in patients with significant renal disease or where significant concern exists for potential neurological impairment or blood loss.

HCR + PEER

During this procedure, revascularization would be provided by techniques for HCR described above. PEER could be performed during the same anesthetic via a femoral approach or possibly through direct left atrial or left ventricular access.

As with CABG + PEER, an advantage is that the need for cardiopulmonary bypass is ***no longer absolute.***

Furthermore, with this approach coronary revascularization is achieved with both PCI and LIMA to LAD bypass, thereby resulting in a less significant incision while providing the long-term benefits of LIMA grafting.

Whether this method provides an equivalent revascularization result as traditional CABG likely depends on the degree of non-LAD coronary disease; but this combination could still be useful in patients who are at high operative risk.

PCI + PEER

This combination of techniques is the **least invasive** and minimizes the significant risks of surgery.

In addition, depending on patient risk factors, these procedures could easily be performed together or staged.

Nonetheless, given the limited efficacy of both procedures in treating multivessel coronary disease and MR, relative to more invasive approaches, only a ***select subgroup of high-risk patients*** with the appropriate coronary lesions suitable for PCI and mitral pathology amenable to PEER could benefit from this approach.

HCR + mini-MVR

In this approach, a left anterior thoracotomy would allow LIMA-LAD bypass , PCI of the non-LAD lesions.

This could be followed by mini-MVR.

This strategy ensures optimal myocardial protection during the mitral correction.

Sternal integrity is also maintained.

In 2014, Santana et al., published the results of over 200 patients who underwent PCI for coronary revascularization followed by a minimally invasive valve procedure.

They found a mortality rate of 3.6% at 4.5 years.

They also demonstrated a decreased complication rate and length of stay for the hybrid group compared to those undergoing conventional sternotomy .

PCI + mini-MVR

Another option for the treatment of IMR consists of multivessel PCI for revascularization followed by mitral repair or replacement through a right anterior thoracotomy.

While these approaches **do not provide the benefits of IMA grafting**, they would provide an alternative for patients with an unusable LIMA or unsuitable LAD target.

Additionally, the ***minimally invasive approach for the mitral valve*** could provide a significant reduction in morbidity.

Although there is less morbidity and mortality associated with a hybrid approach, several groups have observed an increased incidence of **acute kidney injury** when both PCI and a valve procedure are performed on the same day.

This prompted the recommendation of establishing a period of **three weeks between the PCI and valve operation.**

Conclusions

More treatment options exist for IMR than traditional CABG ± MVR.

The potential benefits of employing these techniques include reducing in-hospital morbidity and mortality, especially for high-risk patients.

In many instances, mid- and long-term results for minimally invasive surgical approaches for the treatment of coronary disease and MR compare favorably to those of more conventional surgical procedures.

Percutaneous approaches to the treatment of multi-vessel CAD and MR offer advantages in certain subsets of patients that are unable or unwilling to undergo more traditional surgical procedures.


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END