

## Exclusive Internal Mammary Artery Bypass for Complete Myocardial Revascularisation

a report by

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### Introduction

The internal thoracic artery (ITA) demonstrates superior long-term clinical results after coronary artery bypass grafting (CABG) compared with saphenous vein grafts with 85–95% freedom from significant stenosis at seven to 10 years.<sup>1–4</sup> Moreover, the ITA outperforms other arterial grafts, namely the radial and gastroepiploic arteries, and is now undeniably the conduit of choice for surgical revascularisation. It has unique histological, physiological and haemodynamic features providing an apparent protection from severe atherosclerosis, explaining its long-term permeability.<sup>5</sup>

While bypass of the left anterior descending (LAD) artery by the left ITA has been widely accepted as a major positive prognostic factor in patients undergoing CABG and has been standard for more than two decades,<sup>6–8</sup> purely ITA grafting for triple-vessel-diseased patients by connecting the free right ITA end-to-side to the *in situ* left ITA as a Y-graft, has been reported with encouraging long-term results.<sup>13,14</sup>

### Surgical Technique

The technique consists of complete extra-pleural skeletonised harvesting of both ITA. The fascia is peeled off the ITA while the internal thoracic veins are left *in situ* to preserve a certain degree of vascularisation of the sternum. The ITA is harvested from its bifurcation up to its origin from the subclavian artery to obtain maximum length. The right ITA is divided at its origin and connected end-to-side to the *in situ* left ITA in a Y fashion (ITA-Y anastomosis). The site of this anastomosis depends on the intended course of right ITA to the first sequential anastomosis. Construction of the ITA-Y anastomosis is performed by a linear incision in the left ITA and end-to-side anastomosis of right ITA by a single running suture, before placing the patient on cardiopulmonary bypass (CPB) to avoid prolonging CPB time. Subsequently, the flow in each arm of Y-graft is visually assessed. The left ITA is generally used to bypass the anterior coronary arteries (LAD, diagonal and ramus intermedius) and the right ITA to the lateral and

inferior coronary arteries of the heart (ramus intermedius, obtuse marginal, posterior descending and right posterolateral) in a sequential fashion by constructing parallel and perpendicular anastomoses as appropriate depending on the circumstances.

The clinical results of the ITA-Y and sequential side-to-side ITA-coronary anastomoses have been inferred from clinical signs and cardiac functional assessments (scintigraphy, exercise ECG, etc.) but their patency has also been evaluated by direct graft visualisation (coronary angiography and CT angioscan).<sup>15</sup>

### Discussion

Long-term survival and freedom from angina and myocardial infarction (MI) after CABG are related to many variables, such as patient's pre-operative status, progression of the disease in native coronary arteries, completeness of revascularisation and particularly late failure of bypass grafts.

### Choice of Graft

The bypass conduit appears to be one of the dominant factors in the long-term follow-up. While the saphenous vein has been considered as predominant graft, venous graft atherosclerosis continues to be the major cause of late failure of CABG.<sup>16</sup> Selection of the bypass graft with adequate flow and the greatest longevity is thus of vital importance and consequently the use of ITA instead of saphenous vein grafts is preferred whenever possible. The structure of the ITA is adapted to arterial pressures and high flow-rates and produces greater amounts of relaxing factors, namely nitric oxide, providing a superior reactivity to flow requirements in the coronary arteries.<sup>17</sup> These particularities may explain the possible differences in post-operative graft function and long-term patency rates.

The ITA, with a well defined microanatomy and vascular reactivity, is the ideal bypass conduit since it remains relatively free of atherosclerosis at late follow-up.<sup>18</sup> Clinical benefits and survival advantages of LITA to LAD bypass grafting by comparison with the use of vein graft, are widely established.<sup>7</sup>

Furthermore, the long-term patency of the LITA graft bypass to other coronary arteries is also superior to that obtained with vein grafts or radial artery grafts.<sup>1-3</sup> Likewise, authors have reported similar patency rates of LITA and RITA connected to the same coronary arteries regardless of the targeted coronary artery or whether they are used *in situ* or as free grafts.<sup>19-21</sup>

### One ITA or More?

Recent data suggest that bilateral ITA grafting is an independent predictor of improved long-term survival and freedom from recurrence of angina, late MI, re-operation, angioplasty and other cardiac-related events.<sup>4,9-11</sup> This still remains true when ITA is used as *in situ*, sequential or free graft.<sup>22-24</sup> Additionally, the use of both ITA does not seem to increase the rate of sternal infection as reported by some authors.<sup>25</sup>

Advances in percutaneous transluminal coronary angioplasty (PTCA) have given this therapeutic option a key and irrevocable role in the management of CAD. There has been a considerable and steady increase in the number of PTCA procedures; furthermore, the indications have spread to include triple vessel disease and left main stem lesions, which were classically considered exclusive surgical territory. Surgeons are thus confronted with performing more complex, multiple vessel coronary revascularisation after failure of the PTCA approach. Target arteries are often multi-stented or multi-stenosed with small calibre and poor run-off. Patients are also referred later to surgery with worsening symptoms and greater comorbidities. Thus, the challenge is to achieve complete revascularisation in an unfavourable setting with a greater risk of graft occlusion. Exclusive ITA coronary artery grafting is possible, using multiple ITA-coronary anastomoses, and has shown excellent outcomes at intermediate-term follow-up.<sup>12</sup> Indeed, this technique introduces the concept of coronary arterial tree reconstruction by the most appropriate conduit: the ITA, which is free from atheromatous disease and has excellent long-term patency. It may avoid the sequelae of vein graft atherosclerosis and is not dependent of the unpredictable long-term performance of the radial artery. The use of ITA-Y grafts and sequential side-to-side ITA-coronary

anastomoses allows increasing the number of distal coronary anastomoses avoiding the use of any other type of graft. The fact that in this procedure, total coronary bypass flow is dependent of the flow of the proximal LITA has led to concern whether flow reserve in the LITA is sufficient to supply more than one anastomosed coronary vessel and even more, for the entire heart. Several reports have already concluded that ITA-Y grafts permit complete MR with good perioperative results and that the flow reserve of the proximal LITA is adequate for multiple coronary anastomoses.<sup>26-28</sup>

### Outcomes

Despite favourable clinical outcomes with this technique, the absence of routine post-operative graft visualisation studies might explain why this procedure has not yet been generally adopted. Controversy still persists on whether the ITA-Y grafts and multiple sequential side-to-side ITA-coronary anastomoses are safe to perform. Early angiographic follow-up has allowed controlling the quality of the ITA-Y and sequential side-to-side ITA-coronary anastomoses, and the distal run-offs in the native coronary arteries.<sup>15</sup> This study showed that the risk of anastomotic stenosis is minor (1.1%), and together with occasional graft kinking have both shown to be transient phenomena. Otherwise, competition of flow at conditions of rest was observed in nine patients and could be attributed to an overestimation of the target vessel stenosis severity pre-operatively. Nevertheless, ITA grafts still demonstrated perfect patency. None of these angiographic abnormalities had post-operative consequences as patients had no modification of their ECG and were asymptomatic on discharge. Follow-up by angiography or eventually multi-slice CT scan would prove the superiority of long-term results of this technique.

### Conclusion

Exclusive internal thoracic artery bypass is reproducible and safe to perform routinely. This procedure, although technically more demanding, allows arterial reconstruction of the coronary tree without increasing the post-operative morbidity and mortality, providing complete myocardial revascularisation in triple-vessel-diseased patients with an excellent quality of anastomoses and outcome. ■

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