Internal Mammary Hypoperfusion Syndrome

—— Diagnosis and Treatment ——

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The use of the internal mammary artery (IMA) in coronary artery bypass surgery has increased substantially over the past 20 years, being at present the conduit of choice for most patients. Complications associated with its use occur occasionally and include life-threatening postoperative ischemia or the revascularized myocardium. We reviewed the records of 1,971 consecutive patients who underwent coronary artery bypass grafting over a 5-year period. All operations included an IMA graft to the left anterior descending coronary artery. Twenty-eight of these patients (1.4%) underwent additional placement of a vein graft on the same region as a salvage maneuver for suspected hypoperfusion as a result of IMA failure. All 28 patients showed life-threatening hemodynamic compromise. Twenty-two of the 28 patients (79%) survived. This was the result of immediate surgical correction, which reversed their hemodynamic instability. IMA hypoperfusion was found more frequently in reoperations and in women and diabetic patients. This syndrome is the result of an imbalance between IMA flow and myocardial demand, causing sudden and unexpected myocardial failure. Its detection and expeditious treatment can successfully modify a serious and potentially lethal clinical situation.

(Key Words: IMA; Hypoperfusion)

The internal mammary artery (IMA) has been used for myocardial revascularization for over 40 years. The first surgical experiments were performed by Vineberg in 1946. He demonstrated the development of anastomotic channels between the coronary arteries and an IMA implanted into the left ventricular muscle of a dog. In 1950, he performed the first operation in the clinical setting; others soon followed. Even although patency was demonstrated, he could not prove that there was any increase in blood flow to the ischemic muscle or any clinical improvement. In 1960, Goetz et al. performed the first direct IMA to coronary artery anastomosis in a dog using a sutureless technique with a tantalum ring. The first application in man was by Kollessov in 1966, who used the IMA to construct a bypass to the left anterior descending coronary artery (LAD). In the late 1960s, Green pioneered the use of the IMA in coronary bypass in the United States. Recently, the use of the IMA has been shown to have played an important role in the improvement in long-term survival, and the IMA is held by many surgeons to be the conduit of choice for myocardial revascularization. However, with the increased use of the IMA, complications related to its use, such as postoperative ischemia of the revascularized myocardium owing to inadequate flow, may be seen more frequently.

The objective of this study was to investigate the incidence, clinical presentation, risk factors, surgical management, and outcome of IMA hypoperfusion.

Material and Methods

The records of 1,971 consecutive patients undergoing myocardial revascularization using the IMA were reviewed retrospectively. The operations were performed between January 1988 and November 1992, at 3 hospitals in Honolulu, by several surgeons.
Patients in whom significant myocardial dysfunction was identified intraoperatively or postoperatively, and who required an additional graft or replacement of the IMA with a saphenous vein graft (SVG), were the focus of this analysis. Extensive data collection was available, including age, sex, race, body surface area, left ventricular function, extent of coronary disease, diabetes, previous myocardial infarction, urgency of the operation, and previous coronary bypass grafting (CABG) or percutaneous transluminal angioplasty (PTCA).

For the purpose of this study, IMA hypoperfusion syndrome was considered to be present when there was clinical evidence of unexpected myocardial failure refractory to inotropic support that followed coronary bypass surgery using an IMA. A retrospective proof of the presence of IMA hypoperfusion was considered to be a dramatic improvement in myocardial failure after the placement of a SVG distal to the IMA graft anastomosis. Pathophysiologically, this is the result of a mismatch between IMA flow and myocardial demand. Frequently, the clinical picture was that of a sudden deterioration after an apparently uneventful operation. Hypotension and cardiac arrest occurred unexpectedly while closing the sternotomy, upon transportation, or soon after arrival at the intensive care unit (ICU). In these cases, there was no time to evaluate the patient in a more methodical way with studies such as angiography or echocardiography, as rapid deterioration made prompt treatment mandatory. Intraoperative flows were not measured except by visual assessment of adequacy of flow by the surgeon. The management of a patent saphenous vein graft on reoperations was variable and depended on the individual surgeon's preference.

Other comparisons showed no statistical differences. Unfortunately, data were incomplete and did not allow body surface area and ethnicity to be analyzed as risk factors for development of the IMA hypoperfusion syndrome. Similarly, the risk factors found to be significant (gender, reoperations, and diabetes) were too few to be considered into a multivariate analysis. No sequential, free grafts or bilateral grafts were used on these patients. All grafts were constructed to bypass a high-grade obstruction (over 70%) of the LAD, and a technically satisfactory anastomosis was reported in every case. The mean cross-clamp time was 44 min.

The time that elapsed between completion of the IMA anastomosis and the subsequent saphenous vein grafting ranged from 0 h (intraoperative) to 6 h after arrival at the ICU. In 21 patients, the presentation occurred in the operating room; this resulted in 3 deaths (14%). Seven patients were returned to the operating room after arriving at the ICU; 3 of them died (42%). The overall mortality rate was 21% (6 of 28). All deaths occurred in the operating room or within the first 48 h after the operation. In 4 patients, the IMA was ligated and transected and, in 24 patients, it was left intact after anastomosis of the SVG to the LAD. Nineteen of the 28 patients with IMA failure (68%) required insertion of an intra-aortic balloon pump for hemodynamic support.

Discussion

The use of the IMA for myocardial revascularization has been increasing over the past 20 years from 5–10% in the 1970s to 90% in 1984. The initial successful results following the use of the saphenous vein for coronary bypass grafting delayed the recognition of the superiority of the IMA. However, an important drawback of these grafts became evident after a few years of use. A study demonstrated that 45% of patent SVGs exhibited angiographic evidence of atherosclerosis at 10 years, with 70% of these lesions reducing the diameter of the graft lumen by at least 50%. In contrast, other reports documented a very low incidence (4.2%) of atherosclerosis of the IMA, and impressive long-term patency rates (94%) 3–12 years after surgery. With this combination of facts, a renewed interest in the use of the IMA became evident. Initially, there were concerns about the possibility of inadequate IMA flow to a major coronary artery supplying a large area of viable myocardium. These fears proved to be unfounded, as IMA flow adapted to the myocardial demand.
Along with the increased use of the IMA for myocardial revascularization there has been an increased awareness of potential failure of this graft, including the hypoperfusion syndrome, which is one of the most serious complications. Inadequate IMA perfusion may be due to insufficient length, size, or flow,16 Subclavian steal syndrome,26,27 acute dissection, intramural hematoma,12,13 vessel spasm,28 and anastomotic stenosis have also been associated with failure of this graft. Most of these problems can be detected and avoided in the preoperative or intraoperative period. The technique of dissection of the IMA should be very meticulous, and adequate flow has to be demonstrated. Excessive manipulation of the IMA, including forced dilatation, should be avoided. In the postoperative period it may be critical to control factors that may increase myocardial oxygen demand, such as hypertension and tachyarrhythmias.

Gender has been documented as an independent risk factor for increased mortality following coronary bypass surgery in several series. In 1 study, the hospital mortality following CABG was 1.5 times higher in women.29 A new finding in our study was the significantly increased incidence of IMA failure in women. Women developed IMA hypoperfusion syndrome almost 5 times more frequently than men. The reason for this difference is not clear. Dignan et al.30 found that there was no significant difference in the IMA size between men and women. However, in his experiments with vasoactive drugs, he found that the maximum contraction of the artery in response to serotonin was significantly higher in women. This difference could be caused by interaction between serotonin and serotonin receptors in the vascular smooth muscle. A similar interaction could possibly lead to increased contractile force of the IMA, resulting in spasm and hypoperfusion. These implications have not been proven, but are proposed as a possible physiologic and biochemical mechanism for the higher incidence of IMA failure in women.

Reoperation is a well-known risk factor for complications and mortality following myocardial revascularization. In the present study, we also demonstrate that it increases the likelihood of inadequate perfusion and of developing the syndrome described in this paper. This correlation has been previously reported from the Cleveland Clinic.31 In that series, it was particularly evident when a totally occluded native LAD was irrigated by a stenotic vein graft. The authors recommend implanting an IMA to the LAD and leaving the old SVG in continuity.

Diabetes has been shown to be an independent risk factor for late mortality following CABG.32 However, diabetes has not been previously reported to be associated with IMA failure. The IMA hypoperfusion syndrome was shown in this study to be twice as frequent in diabetic as in non-diabetic subjects. This could reflect a correlation between atherosclerosis of the IMA and diabetes, or more diffuse coronary vasculopathy with limited run-off.

Upon suspecting the IMA hypoperfusion syndrome, strong consideration should be given to immediate supplementation or replacement of the IMA graft with a saphenous vein. The mortality is higher if this syndrome is first recognized in the postoperative period. Additional measures include insertion of an intraaortic balloon pump (IABP). This modality, however, does not represent an optimal treatment when applied as the only intervention. The best option that these patients have is the immediate supplementation of the myocardial blood flow with a SVG to the LAD.

In summary, this study documents the low incidence but serious nature of the IMA hypoperfusion syndrome and the importance of prompt recognition of this complication and its expeditious treatment. We found that women, diabetic patients, and those undergoing reoperations have a higher incidence of IMA failure. The IMA hypoperfusion syndrome should always be considered in cases of unexpected postoperative left ventricular dysfunction following myocardial revascularization.

References

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