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Cardiologists and Cardiac Surgeons; Arteries and Veins

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Studies of bilateral internal mammary artery (BIMA) over the last 75 years numbering 1,336 (Figure 1) have shown benefit of BIMA for patients with: advanced age (≥70 years) Muneretto et al.[1] Medalion et al.[2] Hirotani et al.[3]; urgent/emergent surgery Bonacchi et al.[4], Hirotani et al.[5]; dialysis Kinoshita et al.[6]; reduced ejection fraction (EF) (<30%, 30-50%) Galbut et al.[7]; women Kurlansky et al.[8]. After a first negative results study for BIMA in diabetics, Kouchoukos et al.[9] many further studies showed benefits Matsa et al.[10], Hirotani et al.[11] Lev-Ran et al.[12], Lev-Ran et al.[13], Stevens et al.[14] Katsavrias et al.[15], Toumpoulis et al.[16], Puskas[17], Dorman et al.[18], Kieser et al.[19] and routine use. Pevni et al.[20] of "routine use" of skeletonized internal mammary arteries (IMAs) was prescient for 2008. 42.3% of patients were >70 years. 34.2% were diabetic. Regrettably for patients, surgeons sometimes incise along both legs trying to find a suitable vein instead of using another artery. God must muse why humans go to the farthest reaches of the body the ankle, while "he put IMAs right next to the heart". A pamphlet advertising Sigvaris Compression Stockings states that, 55% of women who have experienced two or more full term pregnancies develop varicose veins. How many women have only one child? (average children/woman globally is 2.3) Maybe this is the reason why women do not fare as well? Veins have one redeeming potential: as per Kim's paper [21], when attached to IMAs, due to vasodilator substances from IMAs and lack of aortic force, they have a similar ten-year graft patency: Composite left IMA (LIMA)-arterial (88%) vs. LIMA-saphenous vein (SV) (95.9%). Note the trend of SV in demonstrating superiority. Whereas there is a finite amount of arterial conduit, venous conduit is usually more copious in comparison. Has God (and Kim) provided us a way to use both?

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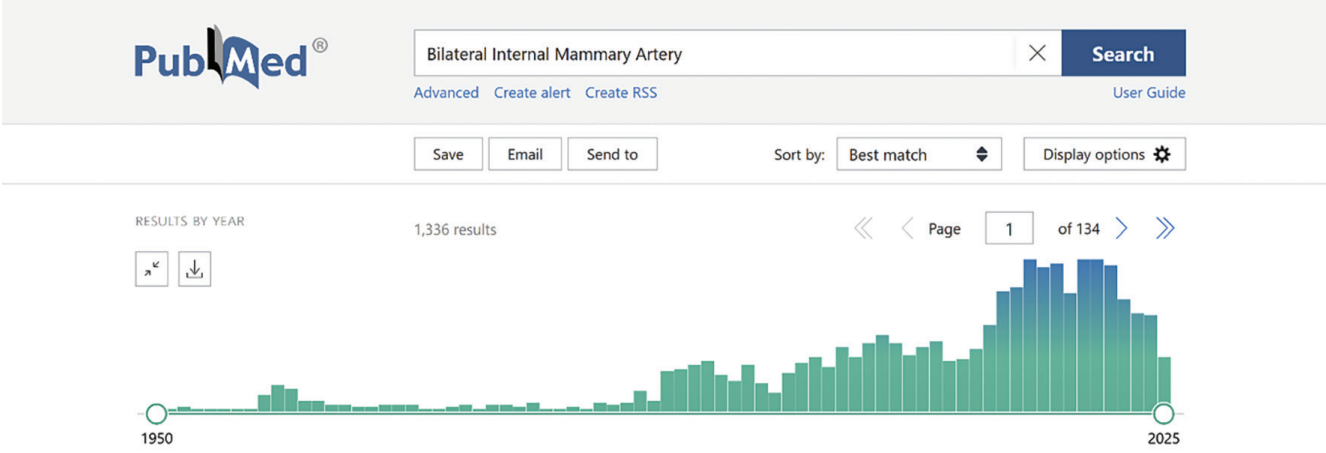

Figure 1. PubMed results published BIMA papers by year 1950-2025
In the last 75 years, there have been 1.336 articles published on bilateral internal mammary arteries

In June 2004, Professor Taggart embarked on the arterial revascularization trial (ART)[22] randomizing between single and BIMAs with a 10-year follow-up. Why was there no difference between single internal mammary artery (SIMA) and BIMA? It was meant to be a trial of one IMA vs. 2 IMAs, but 40% of patients received treatments other than intended ones due to crossover rates: The single internal thoracic artery to BIMA (4%); the BIMA to SIMA (14%); the SIMA with radial artery graft (22%). Gaudino et al.[23] "radial artery superiority over SV" paper was published a year after ART start-up. There was essentially no difference in the "intention-to-treat." Both groups had the same number of arterial conduits. A substantial difference was seen in the "as-treated" group: Significant improvement in both endpoints (all-cause mortality, and especially composite of mortality, myocardial infarction, and stroke). Experienced surgeons (>50 BIMA cases) had much better results at 5 years regarding both endpoints; the curves start to diverge at 2 to 4 years, even with the "intention to treat" group.

Gaudino et al.[24] editorial, after completing the enrollment of 4.375 patients in randomized outcome of multiple arterial grafts (ROMA) (one vs. multiple arterial grafts) on 14 April 2023, lists the key differences between ROMA and ART (respectively). These include primary outcome (major adverse cardiac events vs. all-cause mortality), intervention (multiple arterial grafting vs. SIMA), population (≤70 years vs. all ages), power (event-driven vs. underpowered), and delivery of intervention (experience cut-off: 250 cases vs. 50, continuous vs. no crossover monitoring).

Professor Taggart is responsible for laying the groundwork for ROMA with ART by unmasking how few surgeons actually performed BIMA in everyday practice, and even if they did, they did not feel comfortable enrolling such patients in an randomized controlled trial. Without ART before ROMA, key differences may not have come to light. This author was asked multiple times to join ROMA. The author's arterial grafting experience includes 30% BIMA in the first 15 years of practice, and 78% BIMA for the last 21 years. One criterion would not allow her to do this: The age of 70 years or younger. In all conscience, the author could not say to a 57-year-old patient: "I do not know whether one or two arteries would make a difference to you." She did know… This was especially after she defended her PhD in BIMA grafting in 2015 at Erasmus University, Rotterdam[25]. Having spent 27 years using BIMA in most patients and publishing results from many angles, researchers found there was no equipoise. ROMA has hopefully resolved the debate regarding the benefit of "one vs. more" arterial grafting.

What do the Guidelines say? The 2018 European Guidelines for an additional arterial graft, are Class IIa Level B Evidence[26]. If one considers the age of 70 years[27] as the age below which BIMA grafting can be performed, if the average age of patients in most series is 65-66 years, possibly 66-70% of coronary patients are under the age of 70. Even if one treated 50% of patients under 70 years with BIMA, this would be 34%; if one treated 80% of patients under age 70, this would be 56% - much more than 5% in US and 12% in Europe. However, the 2021 American College of Cardiology/American Heart Association/Society for Cardiovascular Angiography & Interventions Joint Committee on Clinical Practice Guidelines[28] disturbingly assigned coronary surgery and randomized outcome of percutaneous coronary intervention (PCI) the same Class IIb. Also, the phrasing in the Guidelines table in Section 7.1 e23, (Figure 2) is indecisive: "coronary artery bypass grafting (CABG) may be reasonable" and (… the usefulness of PCI to improve survival is uncertain). Certainly, if given a choice, most patients would prefer PCI over surgery, as both are Class IIb with uncertain outcomes.

In many studies, the use of BIMA has not been a point of comparison between treatment arms. For example, it would have been useful if ISCHEMIA[29] had studied the use of 2 arterial grafts in the invasive strategy group. If using a cohort where one internal mammary artery (IMA) is used and the rest are with SV, it may be true that there is no difference when compared with PCI. SV graft patency is at best 50% at 10 years: Fitzgibbon et al.[30], from 1978 to 1996, showed 50%[3], and approximately 25 years later, Tatoulis et al.[31] in 2011 reported no significant difference, showing 50.7%. Various treatments are being compared for diverse patient issues. They are not comparable, just as travel by air and travel by road are not the same. Competition between the two best treatments for coronary artery disease is not in our and, especially, patients' best interest. The roles of PCI and CABG should be considered not as a race, but as a relay. We frequently hand off to each other and are each grateful for this. The value of multi-disciplinary rounds individualizes care for both surgical and PCI patients.

Further thoughts: There are three levels of awareness of cardiac surgical expertise: Surgeons who are acutely aware of their immediate results, cardiologists who treat these patients, and the patients themselves. Cardiologists have known the benefits of total arterial grafting for years, e.g., Raphael Mohr, Tel-Aviv, once stated to the author, "our cardiologists will not refer cases to surgeons who do not perform BIMA." Cardiologists see the untreatable vein graft disease, the disabling chronic angina, and the hesitancy to reoperate on patients with patent single LIMA-left anterior descending grafts. Occluded vein grafts may not kill the patient, but they can destroy quality of life. Cardiologists understand the impact of arterial grafts lasting decades; they follow our patients for this period, whereas we surgeons rarely do. And ultimately the patients…who, when they see you for the first time (and this has happened to this author on more than one occasion), ask "Do you do arterial grafting?" Patients are

Multivessel CAD		
2b	B-R	5. In patients with SIHD, normal ejection fraction, significant stenosis in 3 major coronary arteries (with or without proximal LAD), and anatomy suitable for CABG, CABG may be reasonable to improve survival (10,13-15).
2b	B-R	6. In patients with SIHD, normal ejection fraction, significant stenosis in 3 major coronary arteries (with or without proximal LAD), and anatomy suitable for PCI, the usefulness of PCI to improve survival is uncertain (14-24).

Figure 2. Section from 2021 ACC/AHA/SCAI 2021 Guidelines Table in Section 7.1 e23 showing same recommendation of "2b" for both CABG and PCI

CAD: Coronary artery disease, SIHD: Stable ischemic heart disease, LAD: Left anterior descending, CABG: Coronary artery bypass grafting, PCI: Percutaneous coronary intervention, ACC: American College of Cardiology, AHA: American Heart Association, SCAI: Society for Cardiovascular Angiography and Interventions

browsing the internet, and now there is also ChatGPT available for information retrieval.

Summaries: Technical summary: In order to perform BIMA commonly, one needs to do routinely the things that honour and protect the IMA: Harvest the IMA the best way you know (for the author, it is with the Harmonic Scalpel[32]. The anastomosis must be good enough to last decades. Clopidogrel has enabled grafting of challenging arteries. Protect the devascularized sternum by adding multiple preventive layers against infection. Review your work (transit-time flow measurement epicardial ultrasound)[33].

Be patient, meticulous and methodical. Be prepared to not mind being considered as no longer "the fast surgeon."

Surgeon summary: Successful arterial grafting depends on the "mindset" of the surgeon, with help from mentors, training and cardiological support. Arterial grafting can be used on all patient subgroups with safety and attention to detail. It is not just for some, but for all…

Philosophy summary coronary surgery has come a long way since the days when only one mammary artery was used, when endarterectomy and low EF often necessitated vein grafts. One can connect anything to anything if the connection is technically perfect, with success. Blood flows any and every which way: "Nature abhors a vacuum." (Aristotle 384-322 BC). Coronary disease is lifelong; use of arterial grafts offers the closest possible approximation to a cure. Interventionalists know that to date, there is no PCI option available that competes with the longevity of BIMA. Drug eluting stents can now last 10 years and more, and are rivaling SV grafts.… Consider performing a few more arterial grafts to maintain your employment status.

Arterial grafting routinely treats all patients with the best conduits available, without bias. No longer is it "Just a CABG." BIMA is possibly the most critical intervention a surgeon can do for coronary patients. An extra 20 minutes for an extra 20 years[34]…

One of the youngest patients in the author's Database of 2022 patients over 21.5 years, age 29 years and 14 weeks pregnant at the time of her surgery, said to the author in an e-mail "Doctors always question the scar on my wrist and are astounded to hear that you used arteries in my heart… it makes only sense."

Footnotes

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