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Coronary Sinus Reducers and Internal Mammary Artery Occlusion: Giambattista Vico's Recurring Cycles Within the History of Civilization

With great interest, I read the article by D'Amico et al[1] reporting on the usefulness of a coronary sinus (CS) reducer, a percutaneous endo-luminal stent, for treating refractory angina. The principle behind implanting this device is focal narrowing in the lumen of the CS, which activates a short cascade of events. First, it creates a pressure gradient across the device, including an increase in backward pressure in venules and capillaries. Secondly, it causes microvascular blood redistribution from the less ischemic sub-epicardium to more ischemic endocardium, thereby adjusting the normal blood flow ratio between the heart's layers. Thirdly, it reduces myocardial ischemia and angina. Encouraging empirical results moved the European Society of Cardiology to include this technique in their 2019 guidelines as a valuable treatment for refractory angina, calling it a class IIb recommendation based upon B-level evidence.[2]

Exactly one century ago, Louis Gross demonstrated that the human heart could benefit from three vascular mechanisms to compensate for myocardial ischemia.[3] The most important of these is the widening of intra-myocardial anastomotic channels, especially within the ventricular septum. The second is the development of the *rami telae adiposae*, a microvascular network located in the epicardial mantle bi-directionally connecting to myocardial small vessels and the periaortic and peri-pulmonic vasa vasorum. The third mechanism consisted of connections between small myocardial vessels and extra-cardiac arteries, like the bronchial, intercostal, oesophageal, pericardial and, above all, internal mammary arteries (IMAs), a network that, later in the seventies, was named "noncoronary collateral myocardial blood flow" (or "noncoronary collateral circulation") by cardiac surgeon Gerald Buckberg.[4] Beside these observations, Gross also introduced the principle of CS occlusion, his experiments on canine models, conducted in the thirties, revealing that partial occlusion of the CS (more than complete occlusion) was protective against the ischemic effects of proximal left anterior descending artery ligation.[5] Among 29 dogs on which he tested his theory, 20 survived one to three weeks; and, in more than 50%, the infarct area either was smaller than in control dogs, or absent altogether. Based on the same principle, Mercier Fauteux, in Montreal, ligated the great cardiac vein in dogs in 1935, and performed the first operation in man in 1939, the patient remaining free from angina at two-year follow up.[6] Further operations on subsequent patients followed.

Over the same decade, Davide Fieschi, in Italy, invented the technique of IMA surgical ligation distal to the origin of the pericardiophrenic branch, achieved through a small incision within the 4th or 5th intercostal space.[7] Occlusion of the IMAs had the goal of redirecting blood flow to the heart via these branches. This technique was used successfully by Battezzati in 304 patients and by other groups in the fifties.[7] Although some continued to advocate for its use, this approach ultimately was abandoned after the cardiopulmonary bypass machine was invented and coronary surgery expanded, giving pause to further debate.

Since 2010, after 50 years of obscurity, the principle of IMA occlusion has been resurrected by the current author as a possible tool for treating refractory angina.[8,9] These arteries certainly have high plastic potential in developing collaterals.[10-16] Endovascular embolization or occlusion of the IMAs, using plugs, was suggested, considering also that the theoretical risk of such a procedure is very low, similar to that of simple coronary angiography.[17,18] Over the last eight years, a group of interventional cardiologists in Bern has iteratively demonstrated that, in man, transient or permanent occlusion of the IMAs, distal to the origin of the peri-cardio-phrenic branch, increases the collateral flow index and fractional flow reserve, while decreasing anginal symptoms and ST anomalies on intracoronary electrocardiograms (ECGs).[19,20] They have concluded that permanent IMA occlusion augments extracardiac ipsilateral coronary supply, with the effect of reducing ischemia in the dependent myocardial region. This conclusion is astonishingly in agreement with that of our Italian precursors. Albeit not yet accepted as an established therapeutic option, this method could theoretically become an alternative to CS reducer use, or at least a complementary tool, if both are used in the same patient, certainly warranting further investigation.

As expressed above, CS reducers and IMA occlusion both are principles based upon old concepts, abandoned for decades, but recently resurrected. The famous philosopher Giambattista Vico (Naples, 1668 to 1744) theorized that the history of civilization consists of "corsi e ricorsi storici".[21] In English, this usually is translated as "occurrences and recurrences of history" or as "recurring cycles within the history of civilization." The reappearance and reapplication of old concepts in clinical practice suggests that medicine too is prone to evolutionary and cyclical changes,[22,23] with cardiology no exception.

DECLARATION OF INTERESTS

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Hospitalization Rates Before and After Palliative Care Utilization for Heart Failure Patients (from a Nationwide Sample)

Despite the advancement in heart failure (HF) management, HF remains a progressive disease with substantial morbidity, mortality and considerable burden on the health care system.[1] Palliative care (PC) is an under-utilized, nonpharmacological modality that improves quality of life for HF patients and their families.[2] Previous studies showed a potential reduction in the hospitalization rates with integration of PC; however, the rates remain relatively high (~30%) over 6 months.[2] To better understand the effect of PC on hospitalizations and to put these readmissions into context, we queried the Nationwide Readmission Database (NRD) to explore the change in hospitalizations before and after PC, instead of only focusing on the post discharge readmissions only.

NRD is a publicly available, de-identified, discharge level data from 28 States, and accounts for 58.7% of United States hospitalizations.[3] We analyzed hospitalizations from 2010-2018 using ICD-9/10-codes to identify patients who had PC encounters (V66.7 / Z51.5) during hospitalizations with a primary diagnosis of acute on chronic HF (428.23, 428.33, 428.43 / I50.23, I50.33, I50.43, and I50.813).[4] We excluded patients who died during index admission, or admissions during January-March or October-December to ensure 90-day follow up since the NRD data do not cross the calendar year.[5] The primary outcome was the change in 90-day all-cause hospitalization rate before and after PC. The secondary outcomes were: (1) change in 90-day HF and non-HF hospitalization rates; (2) monthly hospitalization rates before and after PC; and (3) the annual trends of 90-day hospitalization rates before and after PC over the study period. McNemar's test was used to explore the hospitalization rates before and after index admission and a linear-by-linear test was used for the trend analysis over the study period. A p-value of <0.05 was considered statistically significant. This analysis was exempted by the Institutional Review Board as the NRD data are de-identified.

A final analytic cohort of 25,127 admissions were included with a median age of 83 (IQR 67 to 99) years, 51.9% women, and a median length of stay 6 (IQR 1-12) days. Over the 90-day period before and after index admission with a PC encounter, the hospitalization rate for all-cause hospitalization decreased from 56.3% to 22.2% (relative reduction 60.5%, $p<0.001$), HF-related hospitalization rate decreased from 25.0% to 9.3% (relative reduction 62.8%, $p<0.001$), and non-HF hospitalization rate changed from 41.3% to 16.0% (relative reduction 61.2%, $p<0.001$). The 30-day