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Importance of Coronary Artery Disease in Sudden Cardiac Death

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Ventricular arrhythmias, pulseless electrical activity, and asystole can occur at the early stages of an acute coronary thrombotic occlusion, causing hemodynamic collapse, and resulting in "sudden cardiac death." Recognizing this common pathway for adult cardiac arrest, the 2012 European Society of Cardiology (ESC) and the 2013 American College of Cardiology Foundation with the American Heart Association ST-segment elevation myocardial infarction (STEMI) guidelines recommended immediate angiography and percutaneous coronary intervention in resuscitated out-of-hospital cardiac arrest (OHCA) patients whose electrocardiogram (ECG) shows ST-elevation (class I recommendation).[1,2] However, clinical and electrocardiographic data alone are poor predictors for coronary artery occlusion in survivors of OHCAs. In a small, prospective study of 84 OHCA patients, Spaulding et al. showed that neither chest pain preceding arrest nor the presence of postresuscitation STEMI are independent predictors of an acute coronary occlusion.[3]

Nonrandomized studies suggested that OHCA patients, both with and without evidence of STEMI, have improved survival associated with early cardiac catheterization. This was generally defined as cardiac catheterization performed either immediately upon hospital arrival or during hypothermia treatment when the patients were comatose.[4] The benefit was most transparent in those resuscitated OHCA victims without readily obvious noncardiac cause for their arrest. A retrospective, observational study by Hollenbeck et al. demonstrated that comatose OHCA patients with initial documented rhythm of ventricular arrhythmias, but without electrocardiographic criteria for STEMI postresuscitation, have a significantly better rate of survival (65.6% vs. 48.6%) and favorable neurological outcome (60.7% vs. 44.5%) independently associated with early cardiac catheterization.[5] There appeared to be a high incidence of acute coronary artery occlusion regardless of ECG pattern. It was also observed that early cardiac catheterization provided improved outcomes in patients without obstructive coronary lesions, perhaps through early hemodynamic optimization or mechanical support, but possibly simply as a marker of more aggressive postresuscitation management. It may also trigger a more immediate search for other causes of OHCA once obstructive coronary disease has been ruled out.

The European Association for Percutaneous Cardiovascular Interventions/Stent for Life group suggested an algorithm for OHCA survivors without STEMI ECG criteria. They recommended that the patients be evaluated in the emergency department or intensive care unit with selective and appropriate diagnostic tests to exclude noncoronary causes.[6] If a cardiac etiology for the arrest cannot be ruled out, they recommended proceeding to coronary angiography with a view toward intervention if the culprit vessel is identified. If the decision is for coronary angiography, it should be performed immediately (ie, within 2 hours of admission). This recommendation was made in adherence to the 2011 ESC guidelines for management of high-risk non-STEMI acute coronary syndrome with emphasis on hemodynamically unstable patients and those with recurrent malignant ventricular arrhythmias.

Stecker et al. report on, in this issue of the *Journal of the American Heart Association* (*JAHA*), the incidence of sudden cardiac death between February 1, 2002 and January 31, 2003 in a large, community-wide, prospective cohort study conducted in Multnomah County, Oregon, with a population of ≈660 000.[7] They found that pre-existing coronary artery disease (lesions >50%) or previous myocardial infarction (MI) were associated with a 50% or greater increase in survival to discharge, compared to those without documented coronary artery disease (CAD). Pre-existing coronary disease was

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established by medical history or cardiovascular imaging documentation of at least 1 coronary artery with a ≥50% stenosis. Why should pre-existing coronary disease provide a survival advantage to the sudden death victim? The investigators suggest several hypotheses, but perhaps the most intriguing consideration is why isn't pre-existing CAD a disadvantage for surviving cardiac arrest.

The physiology of coronary blood flow has been studied in experimental models almost since the era of closed-chest compression cardiopulmonary resuscitation (CPR) began in 1961.[8] We have previously shown that during cardiac arrest, autoregulation of coronary flow is lost within a short period of time. As a result, coronary blood flow is completely dependent on the coronary perfusion pressure gradient (aortic diastolic pressure minus simultaneous right atrial diastolic pressure) generated by chest compressions.[9] Under these conditions, we found that any coronary lesion, including intracoronary diameter stenoses as minimal as 10%, decreases distal coronary flow. Stenoses of 50% or greater in particular (as described in the report of Stecker et al.) compromise endomyocardial perfusion by decreasing distal flow by half.[10] Physiologically, any coronary narrowing/stenosis should make resuscitation and subsequent survival more difficult, given that CPR-generated myocardial blood flow and return of spontaneous circulation are known to have a direct correlation.[11] Such physiological data make the results of Stecker et al. even more impressive.

Several hypotheses for why OHCA victims with pre-existing CAD have improved outcomes deserve comment. This population is more likely to be on cardiac medical therapy, which typically includes a beta blocker. Data extracted from a prospective, observational study evaluating the effect of prearrest left ventricular ejection fraction on outcome postarrest showed that patients who received beta blockers 24 hours preceding arrest had an improved survival outcome to hospital discharge, compared to those who did not receive the medication (33% vs. 8%).[12] Theoretically, beta blockers would protect against the potentially harmful hyperadrenergic state immediately postresuscitation as well as improve myocardial bioenergetics and decrease myocardial demands peri- and postarrest in the setting of myocardial stunning. However, in a univariate analysis, Stecher et al. found no differences in survival for associated beta-blocker use.

The investigators propose that perhaps ischemic preconditioning might be playing a role in the association between the presence of coronary disease and improved survival from cardiac arrest. Ischemic preconditioning has been well studied in experimental models and humans during the era of balloon angioplasty. Also known as the "warm-up phenomenon," it refers to the myocytes' physiologically adaptive ability to become more tolerant toward a prolonged episode of coronary occlusion if it has been exposed to transient sublethal periods of ischemia. The protective effect of ischemic preconditioning carries important clinical implications given that it decreases the extent of MI, limits endothelial ischemia, and reduces the occurrence of life-threatening ventricular arrhythmias that lead to OHCA as well as arrhythmias associated with reperfusion therapy. A line of studies demonstrated that there was a lower incidence of in-hospital death[13] and 1-year cardiac mortality[14] in patients with previous angina. Although any preinfarction angina yielded protection, it was also suggested, in the TIMI-9B study, that the benefits of preconditioning are greatest within the 24-hour window preceding the onset of infarction.[15] Gheeraert et al. conducted the first human study addressing the incidence of ischemic preconditioning on ventricular fibrillation during acute coronary occlusion.[16] Ischemic preconditioning was defined as a history of either preinfarction angina (an episode of chest pain within 72 hours of the acute MI) or chronic angina. They found that patients with ischemic preconditioning were protected against out-of-hospital ventricular fibrillation during an acute MI, especially those with left coronary artery occlusion.

Regardless of hypotheses on how and why, this report by Stecker et al. adds further fuel to the ongoing discussion about pursuing CAD as the likely culprit behind out-of-hospital cardiac arrest in adults. If the association between pre-existing CAD and improved survival after sudden cardiac arrest is true, then the approach of performing immediate coronary angiography for all survivors should be considered. Early coronary angiography, irrespective of postresuscitation ECG ST-segment findings, provides such survivors definitive treatment for their underlying condition that most likely caused their cardiac arrest.[4]

Disclosures

None.

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