Cardiopulmonary bypass, cardioplegia, confocal inspection...?

Ralph S. Mosca, MD

From the Department of Cardiothoracic Surgery, New York University Langone Medical Center, New York, NY. Disclosures: Author has nothing to disclose with regard to commercial support.

Received for publication April 19, 2016; accepted for publication April 19, 2016.

Address for reprints: Ralph S. Mosca, MD, Department of Cardiothoracic Surgery, New York University Langone Medical Center, 40 E 34th St #3, New York, NY 10016 (E-mail: Ralph.mosca@nyumc.org).

J Thorac Cardiovasc Surg 2016;152:203-4

0022-5223/\$36.00

Copyright © 2016 by The American Association for Thoracic Surgery

<http://dx.doi.org/10.1016/j.jtcvs.2016.04.057>

Luigi Galvani, an Italian biologist, may have been the first to recognize muscle contraction as a result of the application of direct electrical current in the late 1700s.¹ Mark Lidwell described the first successful clinical use of electrical myocardial stimulation in a newborn: “I designed ... a machine by means of which direction stimulation may be applied. ... The needle was plunged into the ventricle and the heart responded to each impulse.”² As cardiac surgery began in earnest, eloquent descriptions of the anatomy of the cardiac conduction system in typical and malformed hearts helped to reduce the rates of surgically induced heart block (HB) (Figure 1).³⁻⁵ The ability to effectively pace the heart resulted in a significant reduction in conduction system-related deaths.⁶⁻¹¹ Increased sophistication and miniaturization of these devices have made them applicable in nearly all clinical scenarios. Despite these efforts, conduction system injury remains a persistent cause of postoperative cardiac morbidity, the treatment of which necessitates lifelong dependence on pacing systems the life spans of which are, at present, less than 10 years.

The article by Liberman and colleagues,¹² a retrospective cohort review of the contemporary data available through the Pediatric Health Information System regarding the need for and risk factors associated with postoperative cardiac pacing, is among the largest of the published analyses on the topic. More than 100,000 surgeries were included in patients with a median age of 0.5 years and a representative list of diagnoses and procedures. The overall risk of postoperative HB (1%) was consistent with early reports. Certain procedures—double switch, atrial switch, Rastelli, and operations involving the crux of the heart—were associated with elevated risk. Length of stay and hospital cost were—not surprisingly—correlated with the need for pacemaker implantation. Center and surgeon volume were not associated with the risk of postoperative HB. Perhaps the most sobering statistic was the fact that the development of HB and the need for pacemaker insertion was found to be associated with subsequent mortality. Setting aside the customarily cited disadvantages of retrospective analyses

A relatively uncommon but persistent cause of perioperative morbidity and mortality.

Central Message

Cardiologists and surgeons have been aware of the vulnerability of the cardiac conduction system for more than 50 years. Despite significant advances heart block remains an important cause of morbidity.

See Article page 197.

using administrative databases; for example, validity and specificity of coding and our inability to imply causality as it relates to mortality, this article¹² is of vital importance in that it shines a spotlight on our inability to eliminate HB as a cause of ongoing morbidity. In fact, the authors concede that in certain circumstances this outcome is “inevitable.”¹²

Perhaps we need to refocus our efforts to avoid and treat HB. Iatrogenic HB (ie, direct disruption, local hemorrhage, or edema) arises most often as a result of our uncertainty of the disposition of the conduction tissues. This can be a result of inexperience or biologic variability. We can remedy the former with more intensive education and simulation training. In patients known to be at increased risk it may be possible to adapt labeling techniques (eg, confocal microscopy) to make these specialized cardiac cells discernible and thus avoidable intraoperatively.^{13,14} Such techniques have been introduced in other subspecialties, including ophthalmology, dermatology, gastroenterology, and urology, with good results.¹⁵⁻¹⁸ Together with gene therapy techniques in development to treat cardiac dysrhythmias we may be able to further reduce the burden and morbidity associated with postoperative HB.¹⁹⁻²¹

FIGURE 1. A relatively uncommon but persistent cause of perioperative morbidity and mortality.

References

- Whitaker ET. A history of the theories of aether and electricity. In: *From the age of Descartes to the close of the nineteenth century*. New York: Hodges, Figgis and Co; 1910:67-71.
- Lidwell MC. Mark Dowley Lidwell—inventor of the cardiac pacemaker. Available at: <https://epfellow.wordpress.com/2010/10/27/mark-cowley-lidwell-inventor-of-the-cardiac-p/>. Accessed May 10, 2016.
- Lev M. The architecture of the conduction system in congenital heart disease III: ventricular septal defect. *Arch Pathol*. 1960;70:530-49.
- Copenhaver WM, Truex RC. Histology of the atrial portion of the cardiac conduction system in man and other mammals. *Anat Rec*. 1952;114:601-25.
- Bharati S, Lev M, Kirklin JW. *Cardiac surgery and the conduction system*. New York: John Wiley and Sons; 1983.
- Lillehei CW, Sellers RD, Bonnabeau RC, Elito RS. Chronic postsurgical complete heart block with particular reference to prognosis, management and a new P-wave pacemaker. *J Thorac Cardiovasc Surg*. 1963;46:436-56.
- Fryda RJ, Kaplan S, Helmsworth JA. Postoperative complete heart block in children. *Br Heart J*. 1971;33:456-62.
- Hokanson JS, Moller JH. Significance of early transient complete heart block as a predictor of sudden death late after operative correction of tetralogy of Fallot. *Am J Cardiol*. 2001;87:1271-7.
- Krongrad E. Prognosis for patients with congenital heart disease and postoperative intraventricular conduction defects. *Circulation*. 1978;57:867-70.
- Gross GJ, Chiu CC, Hamilton RM, Kirsh JA, Stephenson EA. Natural history of postoperative heart block in congenital heart disease: implications for pacing intervention. *Heart Rhythm*. 2006;3:601-4.
- Anderson H, deLeval MR, Tsang VT. Is complete heart block after surgical closure of ventricular septal defects still an issue? *Ann Thorac Surg*. 2006;82:948-57.
- Lieberman L, Silver ES, Chai P, Anderson BR. Incidence and characteristics of heart block after heart surgery in pediatric patients: a multicenter study. *J Thorac Cardiovasc Surg*. 2016;152:202.
- Wolff GS, Alley RD. Intraoperative identification of the conduction system in repair of endocardial cushion defect. *Ann Thorac Surg*. 1977;23:39-44.
- Huang C, Kaza AK, Hitchcock RW, Sasche FB. Identification of nodal tissue in the living heart using rapid scanning fiber-optics microscopy and extracellular fluorophores. *Circ Cardiovasc Imag*. 2013;6:739-46.
- Tavakoli M, Hossain P, Malik RA. Clinical applications of corneal confocal microscopy. *Clin Ophthalmol*. 2008;2:435-45.
- Uhrlich M, Lange-Asschenfeldt S. In vivo confocal microscopy in dermatology: from research to clinical application. *J Biomed Opt*. 2013;18:2121-8.
- Sharma P, Meining AR, Coron E, Lightdale CJ, Wolfson HC, Bansal A, et al. Real-time increased detection of neoplastic tissue in Barrett's esophagus with probe-based confocal laser endomicroscopy. Final results of an international multicenter, prospective, randomized, controlled trial. *Gastrointest Endosc*. 2011;74:465-72.
- Wu K, Liu JJ, Adams W, Sonn GA, Mach KE, Pan Y, et al. Dynamic real-time microscopy of the urinary tract using confocal laser endomicroscopy. *Urology*. 2011;78:225-31.
- Lezaic L, Haddad F, Vrtovec B, Wu J. Imaging cardiac stem cell transplantation using radionuclide labeling techniques clinical applications and future directions. *Debaque Heart J*. 2013;4:218-22.
- Bongianino R, Priori SG. Gene therapy to treat cardiac arrhythmias. *Nature Rev Cardiol*. 2015;12:531-46.
- Yong-Fu X. Cell and gene therapy for arrhythmias: repair of cardiac conduction damage. *J Geriatr Cardiol*. 2011;8:147-58.