

CARDIAC SUMMARY

Why Use Sonomicrometry to Study Cardiac Function

In the attempt to study and quantify the heart and how it works, many physiological parameters have been developed. When studying the heart, two main approaches can be implemented, assessment of global function and assessment of regional function. Since the purpose of the heart is to maintain adequate blood pressure and flow throughout the body, parameters such as cardiac output serve to visualize global cardiac function. However, the heart may be providing consistent mechanical energy to the vasculature, while at the same time, is subjected to vastly varying preload and afterload conditions. It is only within the context of these loading conditions that cardiac function can be properly evaluated. This loading dynamic is best quantified in the pressure-volume (PV) loop. Thus, central to elucidating global cardiac function is an intimate understanding of the relationship between ventricular pressure and volume throughout the cardiac cycle.

The PV-loop can be generated by simultaneously recording ventricular pressure and volume in the working heart. Ventricular pressure can be obtained with an intra-ventricular pressure catheter. Ventricular volume can be obtained with either a conductance catheter or the use of sonomicrometry. While conductance catheters are less invasive than sonomicrometry, our Sonometrics sonomicrometer provides many advantages. Our crystals can be implanted for both acute and chronic studies in a wide range of animals (from horses to mice). Because our crystals need only be placed once, the variability associated with multiple placements and calibrations when using conductance catheters is eliminated. Furthermore, our crystals are not affected by other medical devices enabling the investigator to make multi-instrumented measurements.

Once the PV-loops are generated our advanced CardioSOFT cardiac analysis software enables the researcher to generate a plethora of cardiac parameters including stroke volume, heart rate and cardiac output. More importantly, our software's PV-loop analysis quantifies preload and afterload by generating ESPVR (PRSW, Emax) and EDPVR values (including Tau), which are key indices when describing the loading conditions affecting the heart outlined above. CardioSOFT can also calculate the area within the PV-loop, which not only provides a value for stroke work, but also predicts changes in myocardial O₂ consumption. Furthermore, CardioSOFT can also incorporate data generated from other instruments such as ECG, flow probes, etc for a complete and comprehensive software analysis system. Overall, our Sonometrics digital sonomicrometer hardware and software system can generate accurate data, providing the researcher with a highly applicable analysis of global cardiac function.

In addition to global functional analysis, regional analysis can also yield important information regarding cardiac function. Parameters such as ventricular wall thickness and segmental shortening have become standard indices for quantifying a particular region of the heart muscle. As the heart contracts and relaxes, the cardiac muscle undergoes various changes in wall (LV, RV or septal) thickness and segmental shortening. The magnitude of these changes can be affected by a variety of physiological and pathological processes or pharmacological interventions. Therefore, quantification of these changes provide valuable information.

Wall thickness and segmental shortening can be determined using echocardiography, magnetic resonance imaging (MRI) or sonomicrometry. While echocardiography is less invasive, it requires a crude post-imaging analysis system in order to generate numeric values. MRI provides high resolution but is very costly and not readily available. Our Sonometrics digital sonomicrometer system provides an affordable, high resolution (15 μ M) method of quantifying wall thickness and segmental shortening in real time. Furthermore, no post-imaging analysis is required since measurements are made in millimeter distances. More importantly, the same crystals used to make volume measurements can also be used to make simultaneous wall thickness

and segmental shortening measurements. Thus, our sonomicrometer can provide collateral evaluation of ventricular volume/dimension and wall thickness, another important index of cardiac performance and loading. As with the PV-loop analysis, CardioSOFT is also equipped to execute calculations involving wall thickness and segmental shortening measurements. Altogether, our Sonometrics digital sonomicrometer and software system provides the investigator with the means of performing a thorough examination of cardiac function.

Our Sonometrics sonomicrometer can be used in any cardiovascular research interest. Today, a great deal of effort is directed towards investigating the pathologies associated with heart function. One such pathology is cardiac hypertrophy leading to heart failure. Many animal models have been developed to identify the etiology of heart failure as well as to devise treatment. Crucial to these models is the ability to accurately measure ventricular volume and carry out PV-loop analysis. Our sonomicrometer can be used to make beat-to-beat measurements of ventricular volume for not only acute experiments but also in the chronically instrumented animal, thus providing an applicable method for quantifying volume in your model. Another area of major interest is myocardial ischemia and reperfusion injury. Not only are investigators interested in how the infarct affects global function but also on regional function, particularly the region of the myocardium impacted by the infarct. By implementing our sonomicrometer to measure regional wall thickness and/or segmental shortening in the infarcted area, researchers have the ability to accurately evaluate revascularization techniques and angiogenic compounds or preconditioning protocols. Combine our ability the assess regional cardiac analysis with global cardiac analysis, and the researcher can truly utilize all the advantages of sonomicrometry.

Whatever your research needs might be, our Sonometrics digital sonomicrometer and software provides the investigator with the necessary tools to fulfill their investigative objectives. From acute large animal studies to chronic transgenic models, our sonomicrometer can become a valuable component of your research laboratory. Furthermore, our hardware and software can be customized to meet any unique needs your research may require. Contact us today, to find out further how Sonometrics can help you achieve a new level of research excellence.

References:

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