Did We Misunderstand How to Calculate Total Stroke Work in Mitral Regurgitation by Echocardiography?

Yasushige Shingu, MD, PhD; Yoshiro Matsui, MD, PhD

Background: Total stroke work (TSW) is used for the estimation of cardiac efficiency in mitral regurgitation (MR). We should be cautious about the interpretation of this parameter, especially when it is assessed by non-invasive methods such as echocardiography.

Methods and Results: For the calculation of regurgitant stroke work, regurgitant volume is usually multiplied by left atrial (LA) pressure. However, by considering the left ventricular (LV) pressure-volume loop, it would be more appropriate to multiply regurgitant volume and the LV pressure, not the atrial one.

Conclusions: We might underestimate TSW when we use LA pressure for the estimation of regurgitant stroke work. (Circ J 2012; 76: 1533–1534)

Key Words: Cardiac output; Cardiac volume; Mitral valve

Results

Figure 1 is a schematic of the pressure-volume loops of the normal left ventricle and that with MR. TSW corresponds to the area of the pressure-volume loop and it is an integral of left ventricular pressure (LVP) between the end-systolic and end-diastolic volumes. External pressure parameters such as SBP and LAP are not included in the calculation of TSW. Therefore, the calculation should be rather as follows: TSW=(fSV+RV)×(LVSP–LVDP), where LVSP indicates LV systolic pressure and LVDP indicates LV diastolic pressure. Because LAP is much less than (LVSP–LVDP), the former formula would underestimate TSW. For instance, when you have fSV of 60 ml, RV of 60 ml, SBP of 120 mmHg, and LAP of 20 mmHg, TSW by the former formula is 8,400 and by the latter formula is 12,000 (based on the hypothesis that LVSP and LVDP are almost the same as SBP and LAP, respectively). Therefore, reports using the former formula of TSW for cardiac efficiency would be misleading.

Is MR Always Against “Low-Impedance”?

Figure 2 is a schematic of LV stroke volumes and resistances of systemic and the mitral valve. Systemic resistance (R1) can be described as follows: R1=(ABP–CVP)/fSV, where ABP is aortic blood pressure, and CVP is central venous pressure. MR resistance (R2) can be described as follows: R2=(LVP–LAP)/RV and it depends on the regurgitant orifice area. When R2 is greater than R1, RV would be less than fSV, which means
Discussion

MR has long been described as against “low-impedance” and mitral repair in patients with contractile dysfunction is reported to further compromise contractile function. It is true that after the elimination of MR, the left ventricle loses 1 parallel resistance, resulting in increased afterload (Figure 2). Because MR resistance can vary widely, depending on the regurgitant orifice area, it would be appropriate to describe the elimination of MR as “afterload elevation” for the left ventricle, but not always “loss of low-impedance”.

Conclusion

We might underestimate TSW when we use LAP for the estimation of regurgitant SW.

References