Estimation of the PASP in RVOT Obstruction

As stated previously, in the absence of RVOT obstruction or pulmonary stenosis, the RVSP and the PASP are the same. However, in the presence of RVOT obstruction (including pulmonary stenosis), the RVSP will be greater than the PASP as flow always travels from a higher pressure to a lower pressure area. In this instance, the RVSP will be equal to the sum of the PASP and the pressure gradient across the pulmonary valve (Fig. 11.25):

**Equation 11.34**

\[
RVSP = PASP + \Delta P_{RV-PA}
\]

where RVSP = right ventricular systolic pressure (mm Hg)
PASP = pulmonary artery systolic pressure (mm Hg)
\(\Delta P_{RV-PA}\) = systolic pressure gradient between the RV and PA (mm Hg)

Therefore, by rearranging the above equation, the PASP can be derived as:

**Equation 11.35**

\[
PASP = RVSP - \Delta P_{RV-PA}
\]

where PASP = pulmonary artery systolic pressure (mm Hg)
RVSP = right ventricular systolic pressure (mm Hg)
\(\Delta P_{RV-PA}\) = systolic pressure gradient between the RV and PA (mm Hg)

As illustrated in Figure 11.25, the RVSP and the PASP do not peak at the same point in time and for this reason, the systolic pressure gradient between the RV and PA (\(\Delta P_{RV-PA}\)) is referred to as the ‘peak-to-peak’ pressure gradient. Therefore, the RVSP is equal to the difference between the RVSP and the ‘peak-to-peak’ pressure gradient across the pulmonary valve.

![Diagram of RVSP and PASP](image)

Importantly, the ‘peak-to-peak’ pressure gradient is different to the Doppler-derived pressure gradient which measures the maximum instantaneous pressure gradient between the RV and the pulmonary artery at the same instant in the cardiac cycle. So in order to estimate the PASP via Doppler, the Doppler gradient that best correlates with the peak-to-peak pressure gradient is required; in most instances, this has been shown to be the mean pressure gradient\(^{[11.5]}\). Therefore, the PASP via Doppler can be estimated as (see Practical Example 11.4):

**Equation 11.36**

\[
PASP = RVSP - mPG_{PV}
\]

where PASP = pulmonary artery systolic pressure (mm Hg)
RVSP = right ventricular systolic pressure (mm Hg)
mPG\(_{PV}\) = mean pressure gradient across the pulmonary valve (mm Hg)

However, in patients with very severe or critical PS, the Doppler maximum instantaneous pressure gradient and the ‘peak-to-peak’ pressure gradient correlate extremely well. This is because in critical PS the pulmonary pressure waveform becomes quite ‘flat’, therefore the maximum instantaneous Doppler gradient and the ‘peak-to-peak’ pressure gradient are very similar (Fig. 11.26). Therefore, in patients with critical PS, the PASP is estimated as the difference between the RVSP and the maximum instantaneous Doppler gradient across the valve (see Practical Example 11.5):

**Equation 11.37**

\[
PASP = RVSP - MIPG_{PV}
\]

where PASP = pulmonary artery systolic pressure in critical pulmonary stenosis (mm Hg)
RVSP = right ventricular systolic pressure (mm Hg)
MIPG\(_{PV}\) = maximum instantaneous pressure gradient across the pulmonary valve (mm Hg)

![Diagram of RVSP and PASP](image)

From the spectral Doppler signals below, calculate the pulmonary artery systolic pressure (PASP). Assume that RAP is 8 mm Hg.

![Practical Example 11.4](image)

**Step 1: Calculate the RVSP**

Using Equation 11.29:

\[RVSP = 4 V_t^2 + RAP\]

= 4 (3.152) + 8

= 39.69 + 8

= 48 mm Hg

**Step 2: Calculate the PASP**

The signal across the pulmonary valve is V-shaped and peaks in early systole; therefore, the PASP is calculated using Equation 11.36:

\[PASP = RVSP - mPG_{PV}\]

= 48 - 11

= 37 mm Hg

**Note:** For simplicity, traces have been measured once. In reality, TR velocities should be averaged over the respiratory cycle and pulmonary valve signals should be averaged over at least 2 consecutive cardiac cycles.

![Practical Example 11.5](image)

**Step 1: Calculate the RVSP**

Using Equation 11.29:

\[RVSP = 4 V_t^2 + RAP\]

= 4 (5.662) + 15

= 128 + 15

= 143 mm Hg

**Step 2: Calculate the PASP**

The signal across the pulmonary valve is rounded and peaks in mid systole; this is consistent with critical pulmonary stenosis. Therefore, the PASP is calculated using Equation 11.37:

\[PASP = RVSP - MIPG_{PV}\]

= 143 - 115

= 28 mm Hg

**Note:** For simplicity, traces have been measured once. In reality, TR velocities should be averaged over the respiratory cycle and pulmonary valve signals should be averaged over at least 2 consecutive cardiac cycles.