Fig 2: Pressure vs Flow
Pulmonary artery pressure vs flow data from 4 lungs CON and 5 lungs with PAPAV added to the perfusate. The CON is statistically higher for the range of flows investigated. Error bars are +/- SE.

Fig 3A: Dynamic image/measurement
Image of arteries obtained as a bolus of ISOVUE 300 contract was injected. Right: Absorbance vs distance perpendicular to axis of artery through which the bolus was passing. Solid circles, data, solid line was a model fit to data as described in Clough JAP 71, 2050, 1991.

Fig 3B: Static image/measurement
Diameter (µm) decreases when PAP was used instead of Pa(D). No statistical difference was observed between static conditions PAPAV or CON or during flow and PAPAV.

Fig 4: Diameter vs Pressure (CON)
Diameter vs pressure graphs for 3 different-sized vessels PAPAV from the same rat lung under flow and static pressure conditions. Open red and black circles; A: effect of flow rate, B: effect of increased pressure, on the D-P data, respectively. Solid lines D = D(0) + BP, fit to data, where D is the slope of the D vs P data and D(0) is the intercept when PAP = 0. The distensibility coefficient, α = B/D(0).

Fig 5: q vs D(0)
An illustration of how α was determined from the data shown in Fig 4.

Fig 6: Arterial Distensibility
Dynamic and static arterial distensibility, α (+/- SE) are compared under conditions of PAPAV and CON. With flow and CON, α was statistically smaller than measured with PAPAV. No statistical difference was observed between static conditions PAPAV or CON or during flow and PAPAV.

Pulmonary artery pressure vs flow data from 4 lungs CON and 5 lungs with PAPAV added to the perfusate. The CON is statistically higher for the range of flows investigated. Error bars are +/- SE.

Fig 1: Experimental Setup
Schematic showing setup with x-ray source, rat lung, and detector. Images (left, bottom) were obtained under flow conditions as the bolus of contrast passed through the field of view, (right, bottom) were obtained under static condition with perfluorocetyl bromide to contrast the arterial tree.

OBJECTIVE/METHODS
Determine whether a similar distensibility parameter can be identified with flow as previously measured under static conditions.

1. Isolated lungs from male Sprague-Dawley rats (~300g) were perfused with bovine serum albumin with (PAPAV) and without (CON) to the perfusate. The left arterial pressure (LAP) was set equal to or above the airway pressure (PA).

2. Using the x-ray imaging system, (Fig 1) digital images of the pulmonary vasculature were recorded as a bolus of contrast medium was injected at flow rates of 10, 20, 30, 40ml/min.

3. Change in vessel diameter with flow were measured as shown in (figs 3A,B). The diameter (D) vs pressure (P) data were plotted using pulmonary artery pressure (PAP) as P (figs 4.5).

4. D-P data was fit to a linear regression to determine the slope, B, and zero pressure intercept, D(0).

5. The arterial distensibility coefficient α = B/D(0) was calculated for the range of diameters measured.

6. Repeat above, except the arterial tree was filled with perfluorocetyl bromide. D-P data was measured at 4 static pressures under CON and PAPAV conditions. Calculate q. Compare dynamic to static α.

EXPERIMENTAL CONCLUSIONS
1. Data indicate that distensibility can be described by a single diameter independent parameter, α, under static and flow conditions.

2. Distensibility appeared similar under static conditions with and without papaverine and during flow conditions with papaverine.

3. Distensibility appeared lower during flow without papaverine suggesting that active tone plays an important role in regulating arterial distensibility.

ACKNOWLEDGEMENT
Research was supported by HL 19298, the W.M. Keck Foundation and the Department of Veterans Affairs.

MODEL CONCLUSIONS
Simulations show α determined from using the PAP instead of P(D) results in a lower estimate of the actual distensibility.

Hypothesis: The pressure distribution in the lungs as the result of blood flow can account for the change in α as measured experimentally.

For the model rat pulmonary vasculature:
Assumptions
1. Poisueille flow, constant downstream LAP
2. L = 4 x D
3. α is constant
4. dichotomous branching structure
5. q = 2.7%/mmHg
6. D = D(0) (1 + αP)
7. 17 generations arteries, 17 veins
8. 20 µm smallest vessel size
9. Tree connection: outlet from Dn artery = inlet to Dn vein

Determine whether a similar distensibility parameter can be identified with flow as previously measured under static conditions.