Esophageal Stricture Compliance Measuring Device

T. Fleming, D. Frost, W. Stanford
Advisor: J. Webster Ph.D
Client: M. Reichelderfer M.D.
Dept. of Biomedical Engineering, December 7, 2007

Abstract

We created a device that measures the compliance of esophageal strictures by measuring pressure of the stricture against the dilation balloon and the volume of liquid inside the balloon. LabView displays a real time pressure vs. volume graph from which compliance can be measured.

Problem Statement

Develop a device that can the compliance of esophageal strictures. Then determine the maximum pressure when enlarging the stricture without bursting the esophagus and from this, create an alarm that can alert doctors to a possible perforation of the esophagus.

Background

Esophageal strictures occur in the lower esophagus just above the cardiac sphincter. The main cause of strictures is acid reflux disease but they can also be caused by cancer and genetics. Larger strictures cause the opening of the esophagus to shrink, making it difficult to swallow.

Figure 1: A balloon dilation of an esophageal stricture.

Figure 2: A dialated esophageal stricture.

Design Criteria

• The device must work with the current method of dilation and measure the volume of saline and the pressure within the balloon.
• The device must display the graph in real time and be able to be viewed during the procedure.
• The device must alert the doctor to any possible perforation of the esophagus.
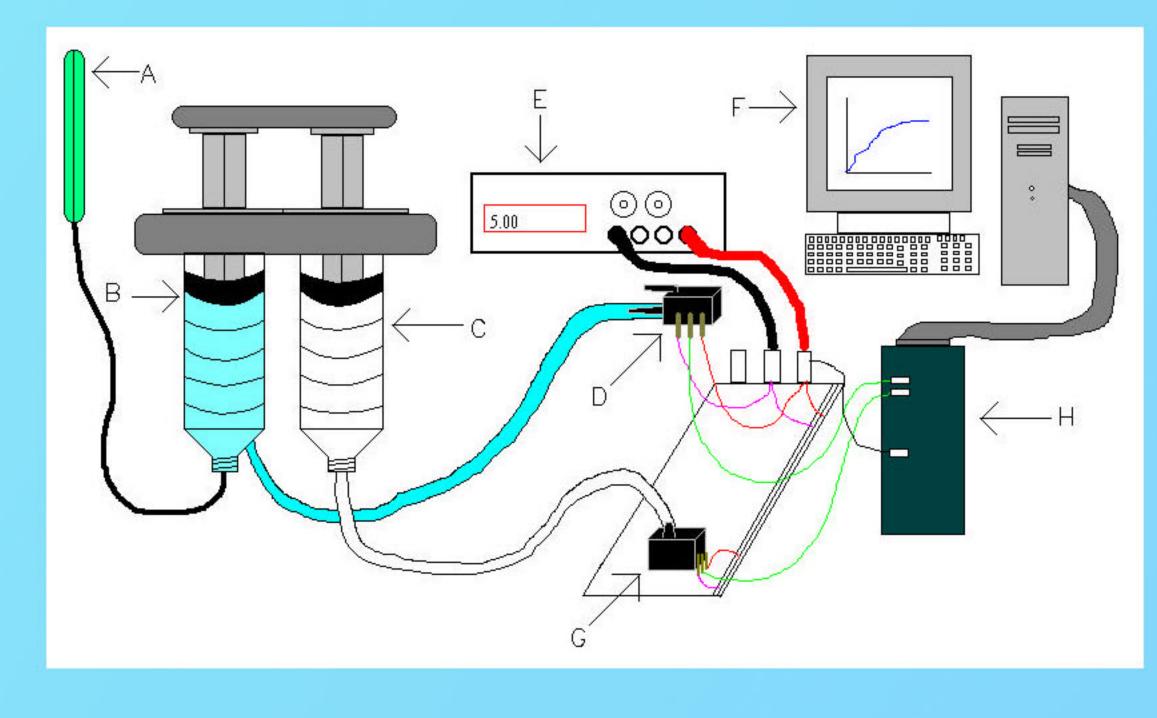
Previous Design

Figure 3: The final design of Spring 2002. Components: A-Balloon, B-Water-filled syringe, C-Air-filled syringe, D-Differential pressure transducer, E-Power supply, F-Computer output, G-Absolute pressure transducer, H-Biobench interface

Previous data were collected using BioBench. The data could not be viewed in real time and had to be exported into a program such as Excel in order to view the compliance graph.
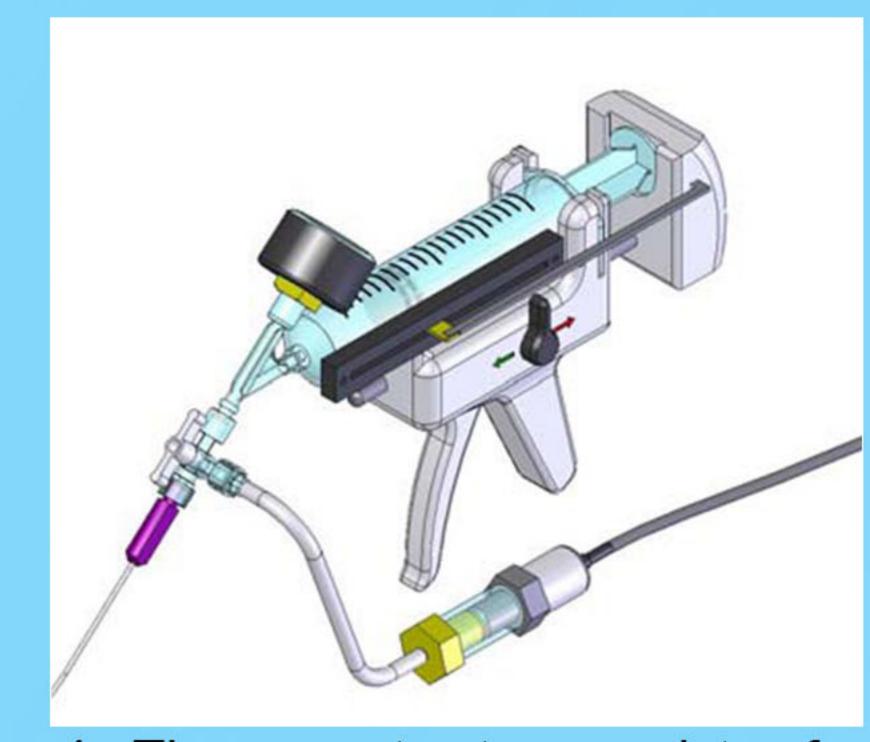
New Design

Figure 4: The current setup consists of a syringe gun with a linear potentiometer attached to its side to measure the change in volume. A pressure transducer attaches at a T -joint to measure the pressure in the
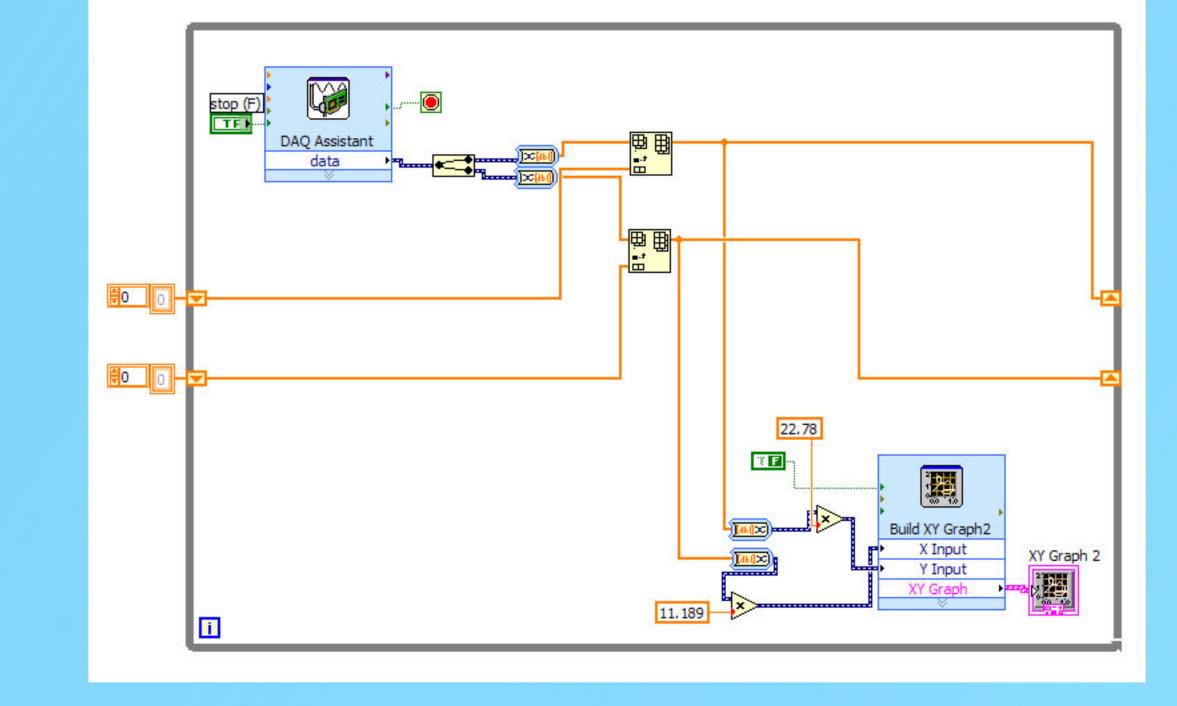
Figure 5: The new LabView program used to acquire the voltage data, convert to untis of pressure and volume and display a real time compliance graph.

References

Hale, A. et. al. (2002). Barostat to Measure Esophageal Strictures.
Insturments, N. (2007). BioBench. Retrieved October 22, 2007, from BioBench: Products
and Services: http://sine.ni.com/nips/cds/view/p/lang/en/nid/1454
Insturments, N. (2007). BioBench: Physiological Data Acquistion and Analysis. Retrieved October 22, 2007, from BioBench: Products and Services: http://www.ni.com/pdf/products/us/1msw155a.pdf

Insturments, N. (2007). LabView: 20 Years of Innovation. Retrieved October 22, 2007, from LabView: http://www.ni.com/labview/
Kirking, H. et. al. (2002). Barostat to Measure Esophageal Strictures.
Seashore, K. et. al. (2006). Device for Dilating Esophageal Strictures.
Vasudeva, R., Deal, D.R. (2006). Esophageal Stricture. Retrieved October 22, 2007, from WebMD: Emedicine: http://www.emedicine.com/med/topic744.htm.

Compliance Data
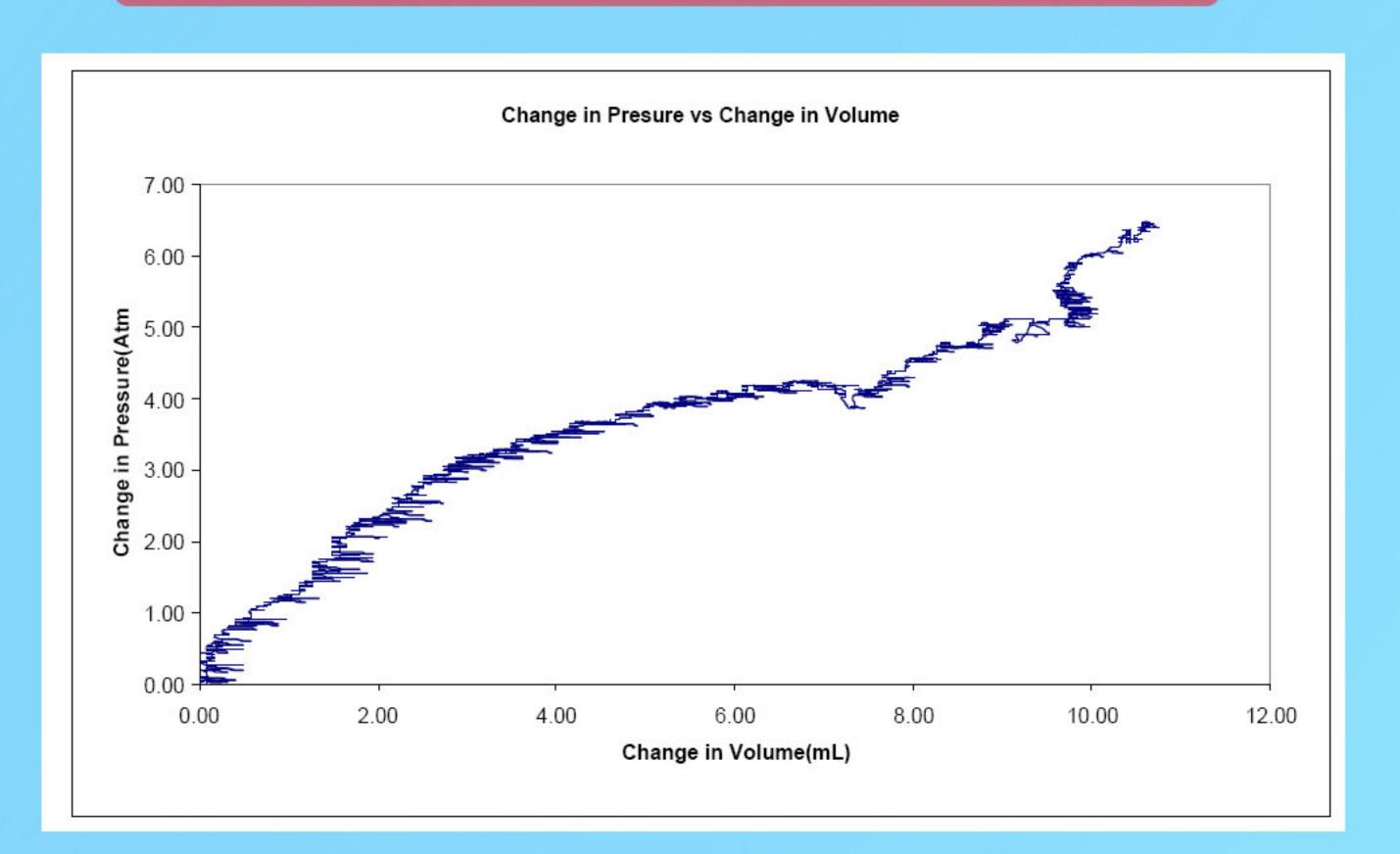
Change in Presure vs Change in Volume

Figure 6: Previous compliance graph made with Excel and original device setup. The balloon had no restriction when being inflated.
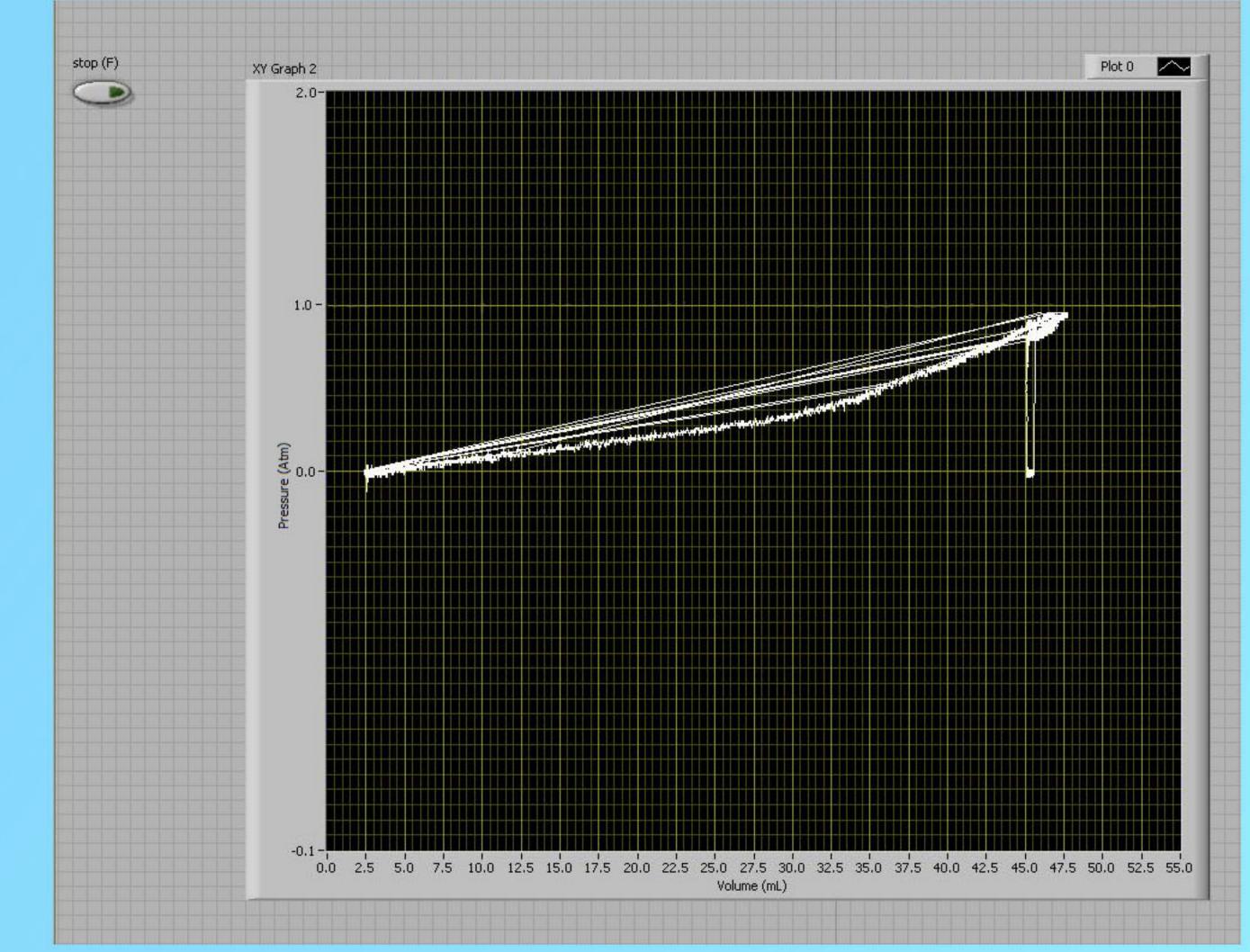
Figure 7: New compliance graph made with LabView. The x-axis is calibrated in milliliters and the y axis is calibrated in atmospheres. Pressure was applied to the balloon during inflation. The drop at the end simulates a rapid reduction in pressure. Air was used to fill the balloon. In the future, saline will be used instead of air.

Future Work

• Configure device with new sensor
• Test the device on animals and humans
• Contain pressure sensor and power supply in compact form for hospital setting
• Configure perforation alarm after testing
• Configure interface between computer and inputs