# Comparison of Standard Blood Pressure Cuff and a Commercially Available Pressure Biofeedback Unit While Performing Prone Lumbar Stabilization Exercise

Ward Mylo Glasoe, PT, MA, ATC
Reginald R. Marquez, MPT
Whittney J. Miller, MPT
Anthony J. Placek, MPT

## INTRODUCTION

Biofeedback is used to complement stabilization exercises for patients suffering back pain.[1] The pressure biofeedback unit (PBU) developed by the Chattanooga Group in Hixson, TN is a commercial device for which exercise protocols are described.[2-4] The PBU is a 3-chamber air filled bladder with attached gauge (Figure 1) that indirectly measures movement during exercise through changes in bladder pressure. One protocol recommends the action of 'hollowing' the abdomen to recruit the transversus abdominus muscle (Figure 2).[4] The bladder of the PBU is inflated and placed under the lower abdomen. The individual contracts the muscles of the lower abdomen with intent to reduce the pressure registered by the PBU. The principle underlying the biofeedback is that isolation in the recruitment of the transverse abdominus occurs when the hollowing contraction drops the pressure of biofeedback between 6 to 10 mmHg. Unwanted substitution by other muscles is inferred if the pressure increases or if the pressure drops by more than 10 mmHg.[4,5]

Blood pressure cuffs are required equipment in all clinics. Like the PBU, the pressure cuff is an inflatable bladder with an attached gauge (Figure 1). Since clinics already have a blood pressure cuff, perhaps this instrument might be adequate to provide pressure feedback to individuals performing stabilization exercise in prone. The purpose of this study was to examine whether cuff pressure measurements correlate with PBU measures obtained during the performance of prone stabilization exercise.

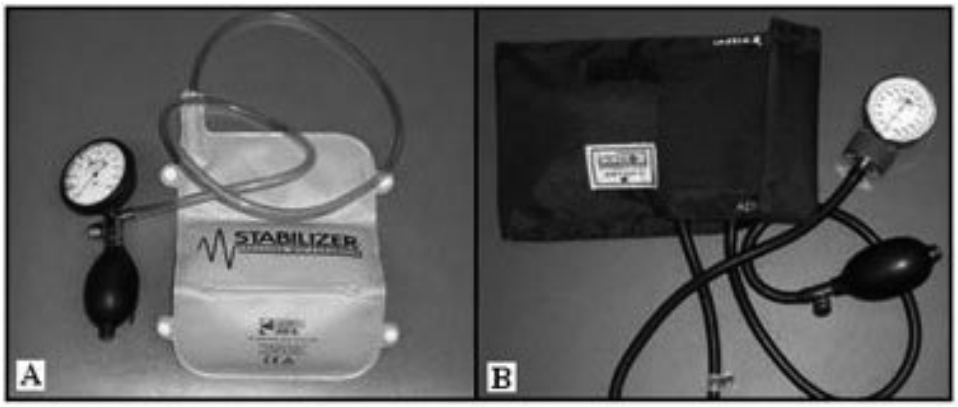


**Figure 1.** Pressure measurement devices used in this study. (A) Pressure Biofeedback Unit. (B) Standard blood pressure cuff.

**Figure 2.** Prone exercise with pressure biofeedback monitoring spinal movement.

## METHODS

### Subjects

The Institutional Review Board of Northern Illinois University approved this study and informed consent was obtained. Eighteen college students, 9 male and 9 female, were tested. Age ranged from 20 to 30 years. Each volunteer completed the Oswestry disability questionnaire to assess the degree of functional impairment associated with low back pain.[6] Oswestry scores averaged 4% (range 0 to 23%) indicating minimal disability. Ten of the 18 subjects scored themselves as having 0% disability. Excluded were subjects with severe spinal disability as identified by Oswestry scores greater than 60%, and subjects who were pregnant.

### Procedures

Subjects underwent a session of training using the PBU. Subjects were positioned prone on a firm mat. The PBU was placed beneath the abdomen just proximal to a line running between the anterior iliac crests and centered relative to the naval.[4] Subjects practiced drawing the abdomen up-and-in

towards the spine under the guidance of an instructor self-trained in the prone hollowing regimen of exercise. The session concluded when the instructor was satisfied that the subject could perform the hollowing exercise while breathing normally and without substitutionary co-contraction of the gluteus maximus and erector spinae muscles.

Subjects rested for 30 minutes and were then randomly assigned to each of the 2 test conditions (PBU vs. Cuff). The prone stabilization exercise technique used in this study has been described elsewhere.[4,5] The device placed beneath the abdomen was inflated to baseline pressure. The PBU was inflated to 70 mmHg of pressure, the value displayed with 2 mmHg resolution on a dial gauge (Figure 1).[4] Based on subject experience, the cuff inflated to 40 mmHg of pressure felt similar to the PBU. Subjects performed 10 repetitions, holding each hollowing contraction for 8 seconds. A 10-minute rest was given between test conditions.

Two examiners worked together to collect the data. One examiner gave commands to the subject, the other recorded the mean drop in mmHg pressure registered on the device.

### Data Analysis

Converting the data to percentage of pressure decrease allowed the PBU and cuff measurements to be statistically compared to assess agreement. An intraclass correlation coefficient (3,1) and their 95% confidence interval (CI),[7] and standard errors of the measurement (SEM) were calculated.

## RESULTS

Table 1 shows the descriptive statistics for the recorded data. An ICC of 0.67 was the level of agreement between the 2 methods of pressure measurement. The 95% CI limits around the ICC point estimate ranged from 0.29 to 0.86. The SEM value for percentage of pressure decrease was 3%, indicating consistency between measures occurred in a small range.

## DISCUSSION

Results of this experiment support the use of a standard blood pressure cuff to provide biofeedback for prone stabilization exercise. An ICC of 0.67 shows there was fair agreement for the percentage of pressure decrease between methods. Figure 3 scattergram data pattern is offset, and shifted above the line of identity towards the 'y' axis representing the cuff. This indicates that the percentage drop registered with the cuff was consistently larger but related. The drop in actual pressure recorded by the examiner for the two methods was remarkably similar (see Table). These findings suggest that the prone hollowing protocol advocated by the manufacturer of the PBU can be replicated using a standard blood pressure cuff inflated to 40 mmHg.

The authors recognize several limitations of the study. Examiners were not blinded, the devices were not calibrated nor were reliability of the measures assessed, and without concurrent EMG data the suggested relationship between biofeedback and muscle activation is speculation. Furthermore, few subjects had back pain. While the subjects tested represent a younger population that

**Table 1.** Descriptive Statistics of Drop in Pressure Recorded with the Cuff and PBU (N = 18)

| Measurement | Mean | Range | SD |
|---|---|---|---|
| Cuff inflated to 40 mmHg<br>Drop in pressure<br>Percent drop in pressure | 2.7 mmHg<br>6.7 % | 1 to 6 mmHg | 2.0 |
| PBU inflated to 70 mmHg<br>Drop in pressure<br>Percent drop in pressure | 2.6 mmHg<br>3.7 % | 1 to 7 mmHg | 1.8 |

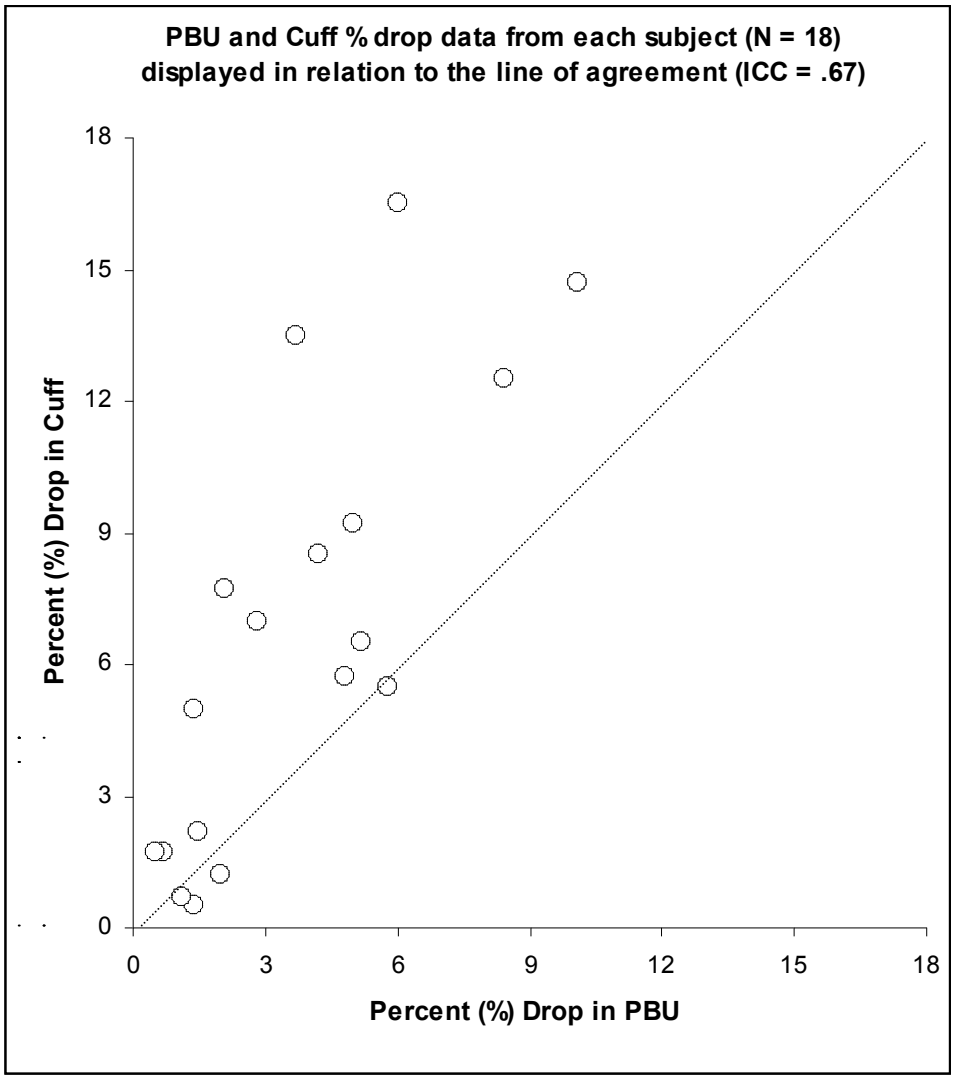


**Figure 2.** The percent (%) drop in the PBU and cuff displayed in relationship to the line of identity with the calculated intraclass correlation coefficient.

could develop back pain, a larger more diverse sample would facilitate the generalizability of the data. Results could differ for other varied patient populations.

Difference in the material design of the devices in conjunction with the prone test position may have affected readings. Materials used to construct the PBU are nonelastic. By contrast, the blood pressure cuff is built from materials that expand when inflated. In prone the contour of the spine and abdomen flattened the cuff, and in effect, prevent it from expanding when inflated. Other stabilization exercise protocols[2,3] that incorporate measures of pressure biofeedback require the individual to lie supine with the PBU placed beneath either the low back or neck. We did attempt to monitor cuff pressure while the individual exercised in supine. However, highly variable readings were found because the cuff inflated and rounded into the curvatures of the spine.

## CONCLUSION

Stabilization exercises are a popular treatment for patients with back pain. The PBU is the common pressure biofeedback instrument for which exercise protocols are described. Data presented in this work suggest that a blood pressure cuff may be used as an acceptable alternative to provide biofeedback when performing prone lumbar stabilization exercise.

## REFERENCES


1. Asfour SS, Khalil TM, Waly SM, Goldberg ML, Rosomoff RS, Rosomoff HL. Biofeedback in back muscle strengthening. *Spine.* 1990;15:510-513.
2. Jull GA, Barrett C, Magee R, Ho P. Further clinical clarification of the muscle dysfunction in cervical headache. *Cephalalgia.* 1999;19:179-185.
3. Richardson CA, Jull GA. Muscle control-pain control. What exercises would you prescribe? *Man Ther.* 1995;1:2-10.
4. Storheim K, Bo K, Pederstad O, Jahnsen R. Intra-tester reproducibility of pressure biofeedback in measurement of transversus abdominis function. *Physiother Research Int.* 2002;7:239-249.
5. Richardson CA, Jull GA, Hodges PW, Hides J. *Therapeutic Exercise for Spinal Segmental Stabilization in Low Back Pain: Scientific Basis and Clinical Approach.* London: Churchill Livingstone; 1999.
6. Fairbank JC, Couper J, Davies JB, O'Brien JP. The Oswestry low back pain disability questionnaire. *Physiother.* 1980;66:271-273.
7. Shrout PE, Fliess JL. Intraclass correlations: uses in assessing rater reliability. *Psychol Bull.* 1979;86:420-428.



*Ward Mylo Glasoe is an Instructor at the Program in Physical Therapy at the University of Minnesota in Minneapolis, MN. Reginald R. Marquez, Whittney J. Miller, and Anthony J. Placek were (at the time of the study) Physical Therapy Students at Northern Illinois University in DeKalb, IL.*