Telemedical neuropathy testing may simplify the diagnoses of patients who live in rural areas, are homebound, or who would otherwise be inconvenienced by an in-clinic visits. Demonstration of a standardized technique could also improve practice and communication between patients and telemedicine providers.

This experiment explored a novel telemedical approach for testing neuropathy where patients self-test their own nerve loss using an inexpensive, easily accessible material rather than a standard clinical monofilament: Barilla "angel hair" pasta. Barilla did not sponsor this research or this article. The Barilla brand was selected due to statistics stating it is the top-selling brand of pasta in the United States [13], making it widely available and reasonably priced for telemedicine patients.

Our goal was to determine a method of breaking the thin, brittle angel hair pasta in such a way that it would match the same 10 gram equivalent force to that measured in clinical settings when bending a standard clinical monofilament. The 10 g equivalent force is the threshold for determining loss of self-protective nerve sensory ability and the standard for neuropathy testing [14,15]. Our target goal of variability was ± 10% from this threshold value, which is considered acceptable by AMA Guides. The breaking point of a pasta noodle would be comparable to the bending point of a monofilament used by providers in a clinic setting.

The materials used in this lab analysis included two different types of Ohaus scales: a Scout Pro SPE601 and AX622/E. No differences were found in the results for one scale compared to the other. Other materials included regular Barilla angel hair pasta, Mr. SIGA Heavy Duty Scrub sponges, a ruler, an X-Acto knife, and 10 g monofilaments. The monofilaments (UPC: 794438512661, Item model number: 08151705) were purchased from JAMAR and tested as shown in Figure 1 (left).

Figure 1: Demonstration of a standard clinical monofilament as it is used in practice (left), and the Press Method (middle) and Pinch Method (right) presented in this study.

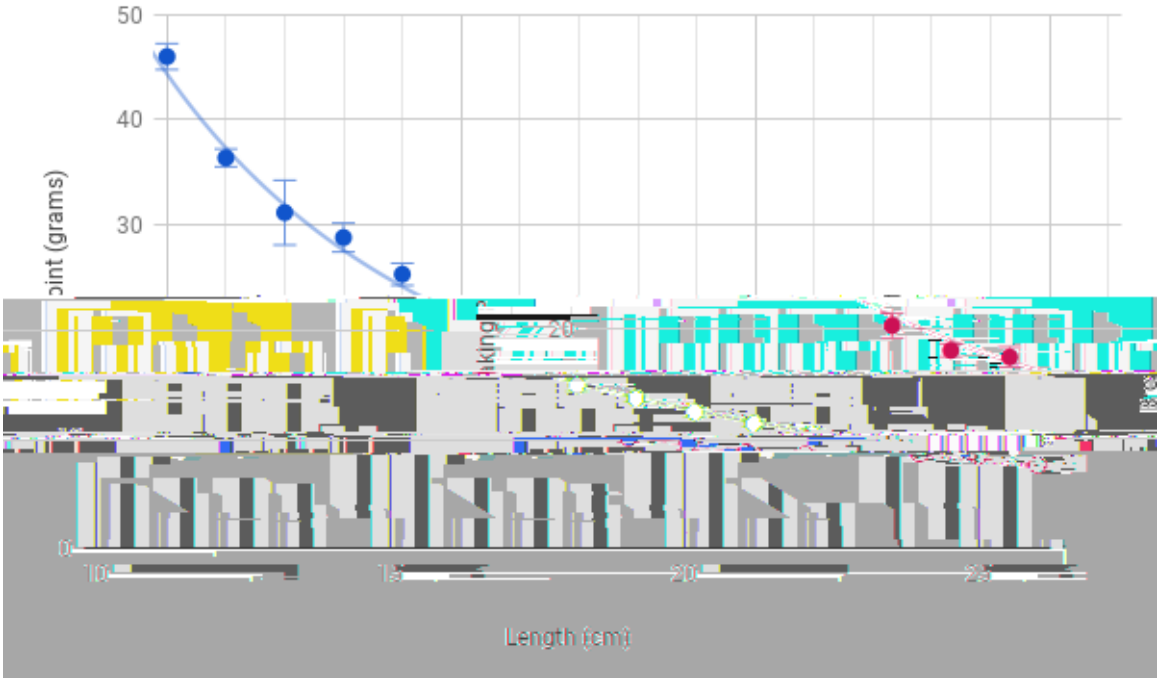

Figure 2: Determining a general relationship between breaking point and noodle length (the solid curve is a guide for the eye).

Next, we used the Pinch Method and varied which researcher was breaking the noodle, to determine variance between experienced individuals using this method. 102 noodles were cut, 34 for each of the three members of the research group. The average breaking points for the individuals were calculated and found to be 9.93 g, 10.40 g, and 10.31 g with standard deviations of 0.42 g, 0.54 g, and 0.56 g respectively. The combined average and standard deviation from all three of the researchers was 10.21 g and 0.54 g, respectively, which was within the accepted error range of ± 10%.

We interpreted the consistency of these results by concluding that no discernible difference was found in comparing results obtained by different researchers. Additional tests of more materials suggest that protocols could be developed that would allow patients to adapt these procedures depending on the availability of pasta.

Volunteers were solicited from the general student body of Hamline University to test the procedural variation within a randomized group of procedure testers. To determine the best way to instruct people to perform the experiment, three different approaches were taken. A volunteer was asked to perform (1) the Pinch Method with only verbal instructions, (2) the Pinch Method with both verbal and visual instructions, and (3) the Press Method. The average breaking points for each test were calculated and found to be 13.70 g, 12.48 g, and 11.00 g with regard to the expectation that

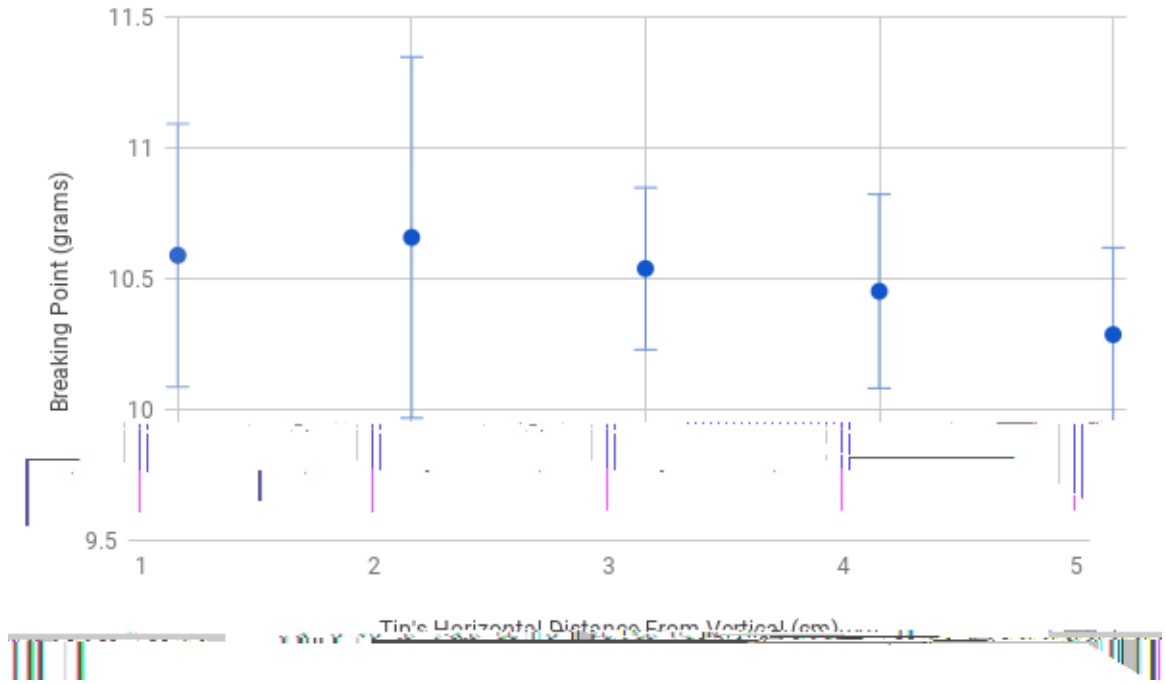

Figure 3: The effect of a horizontal tip displacement on the breaking point of 23 cm length pasta.

For the next test, a randomized group of procedure testers was again solicited in order to best simulate our intended application of this procedure. Twenty volunteers were identified, each of whom broke 50 noodles using the Press Method. The average breaking point and standard deviation for all volunteers was found to be 10.39 g and 0.78 g, respectively.

As a final test, we compared how our results from the 20 volunteers compared to standard clinical monoflaments used today by testing the bending point of JAMAR brand monoflaments. The monoflament is supposed to bend when the 10 g equivalent force is reached. The averages and standard deviations of the monoflaments were calculated and graphed in Figure 4.

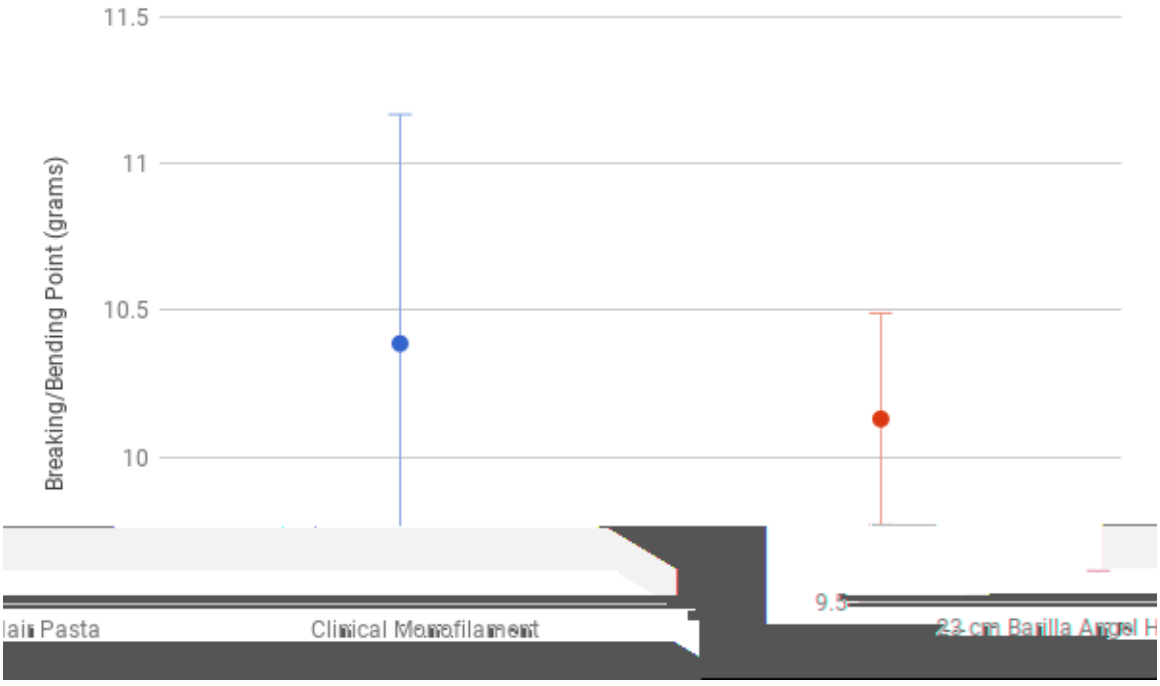

Figure 4: Comparing the effectiveness of the angel hair noodles to standard clinical monofilaments.

Based on these results, neuropathy testing performed by patients using the Press Method with Barilla angel hair pasta can serve as a reasonably accurate substitute for the monofilament procedure that is currently performed by doctors in a traditional clinic setting. While further testing of different types of pasta under different environmental conditions is necessary, using this method under similar conditions can provide telemedicine patients with the ability to test them for nerve loss using an inexpensive, easily accessible material.

All experiments were performed by three research students under the supervision of Drs. Jerry Artz and Bruce Bolon at Hamline University in St. Paul, MN, and volunteers selected at random from the Hamline University student body. Ethical approval was obtained by the Hamline IRB.

1. https://my.clevelandclinic.org/health/diseases/14737-neuropathy
2. www.healthline.com/health/peripheral-neuropathy
3. Dellon AL, Kallman CH (1983) Evaluation of functional sensation in the hand. J Hand Surg 8: 865-70.
4. Bhattacharya J, Neuhauser F, Reville RT, Seabury SA (2010) Evaluating permanent disability ratings using empirical data on earnings losses. J Risk Insur 77: 231-260.
5. Moberg E (1990) Two-point discrimination test. A valuable part of hand surgical rehabilitation, eg in tetraplegia. Scand J Rehabil Med 22: 127-134.
6. Weinstein S (1993) Fifty years of somatosensory research: from the Semmes-Weinstein monofilaments to the Weinstein Enhanced Sensory Test. J Hand Ther 6: 11-22.
7. Periyasamy R, Manivannan M, Narayanamurthy VB (2008) Correlation between two-point discrimination with other measures of sensory loss in diabetes mellitus patients. Int J Diabetes Dev Ctries 28: 71.
8. Andersson G, Cocchiarella L (2000) Guides to the evaluation of permanent impairment. American Medical Association (5th edn), USA.
9. Rondinelli R (2008) Guides to the evaluation of permanent impairment. American Medical Association (6th edn).
10. Feng Y, Schlösser FJ, Sumpio BE (2009) The Semmes Weinstein monofilament examination as a screening tool for diabetic peripheral neuropathy. J Vasc Surg 50: 675-682.
11. Eron L (2010) Telemedicine: The future of outpatient therapy?. Clin Infect Dis 51: 224-230.
12. Wootton R (1996) Telemedicine: A cautious welcome. Br Med J 313: 1375-1377.
13. www.statista.com/statistics/189677/top-spaghetti-and-macaroni-and-pasta-brands-in-the-united-states/
14. Ovid Technologies (Wolters Kluwer Health) (2004) Assessing protective sensation with a