EAN 2019
57th conference on experimental stress analysis

Use of durometer to determine trapezius muscle relaxation

ŠTOČEK Ondřej[1,a], HAVLÍČEK Martin[1,b], LOPOT František[1,c] and KUBOVÝ Petr[2,d]

[1]CTU in Prague, Faculty of Mechanical Engineering, Department od Designing and Machine Components Technická 4, 166 07 Prague 6, Czech Republic

[2]Charles University in Prague, Faculty of Physical Education and Sport, Department of Anatomy and Biomechanics, Jose Martího 31, 162 52, Prague 6, Czech Republic

[a]ondrej.stocek@fs.cvut.cz, [b]martin.havlicek@ fs.cvut.cz, [c]frantisek.lopot@ fs.cvut.cz, [e]kubovy.petr@seznam.cz

Keywords: Durometer, Palopation test, Myotonometer

Abstract:
Measurement of the muscle tension are normally done with specialized apparatus, a.k.a. myotonometers. These devices need specialized personnel, sophisticated electric drive, feedback control and mostly static construction. Hence the high purchase and operating costs of these devices. For these reasons, the requirement for our device arose. The basic requirements are the manual size of the apparatus and the possibility of measuring various muscles all over the body. The apparatus works on the principle of indentor injection into the tissue. The measured quantity is the resistance that the tissue puts. The maximum indentation depth is adjustable and constant during all partial measurements.
Another use of apparatus is to objectify the Palpation Test. The evaluation of this test is highly subjective and depends on the experience of the implementing specialist. With help of this apparatus it is possible to visualize result while facilitating the transfer of experience among clinical experts.
The apparatus is designed to by attached to the respective muscles and the indentor is manually pushed into the muscle. A compression spring is used to reverse movement. The threaded rod is used as a beam between the measuring sensor and the handle. This makes it possible to use nuts as an adjustable depth of indentation. The measuring sensor is one-axis pressure gauge from Kisler.

Introduction

This paper deals with the device for measurement of the muscle tension in various modes of human musculoskeletal activity. The demand for its development was initiated by the Department of Physiotherapy and Anatomy and Biomechanics, Faculty of Physical Education and Sport at Charles University (FPES) to enable the palpation test with a simple portable apparatus. On the market there are available various types of specialized apparatus, a.k.a myotonometers. The absolute majority of them are quite sophisticated with the electric drive and feedback control and they are thus relatively expensive and often non-mobile apparatus. Practically without the exception is the principle of all instruments inspired by the durometric principle, where the indentor is at a constant speed pushed into the superficies of the muscle. The device measure two parameters: the indentation depth and the reaction force of loaded tissues.

Palopation tests are an indispensable part of soft tissue examination methods. Based on this, is a diagnosis of the patient problems, source localization or area of clinical manifestation of the problem and the success of the intervention is monitored. Because is performance and evaluation of the palpation test heavily dependent of the experience of the practitioner, there is an understandable attempt to objectify of such findings and activities so that can by information about them better transferred between clinical expert within the scope learning process and minimize risk of potential negative human impact in clinical application.

Requirements for the properties of our mynotonometer – assignment

Requirements for the properties of our apparatus arose from the fact that it should primarily serve the needs of teaching physiotherapists and possible the research of muscle tone within the scope of diploma and dissertation theses of FPES students.

- The apparatus must by design for manual control manual (max. weight 0,5 kg).
- The apparatus must enable measuring different muscles on the body.
- The apparatus must record measured data.
- The apparatus must represent measuring data online on a display.
- The apparatus must by easy to use.
- The apparatus may not be able to measuring force and depths of the indentor over time – the maximum values achieved are important.
- The apparatus must be producible at minimum cost:
    - Utilize the production possibilities of the technological hinterland of the laboratory BEZ, Department of Anatomy and Biomechanics.
    - Utilize the sensors and measuring technology of the laboratory BEZ, Department of Anatomy and Biomechanics.

Similar to commercially available apparatus, we have used the durometric principle of indentor

Properties of our mynotonometer – compliance assignment

Base on the given assignment, we designed an apparatus with the following properties and the following design:

- Drive: Manual.
- Depth indent of indentor: Non-measured, constant and configuratable for goven measurements.
- Indentor force: Measured throughout pushing.
- Sensor: Kisler 9317
- Measuring station: Dewesoft Sirius
- Control software: Dewesoft X3
- Sampling frequency: 1000 Hz
- 3D printing (string): body of the apparatus
- 3D printing (lithography): indentor, push handle
- Other components: standard machine components

Constructional solutions our mynotonometer:

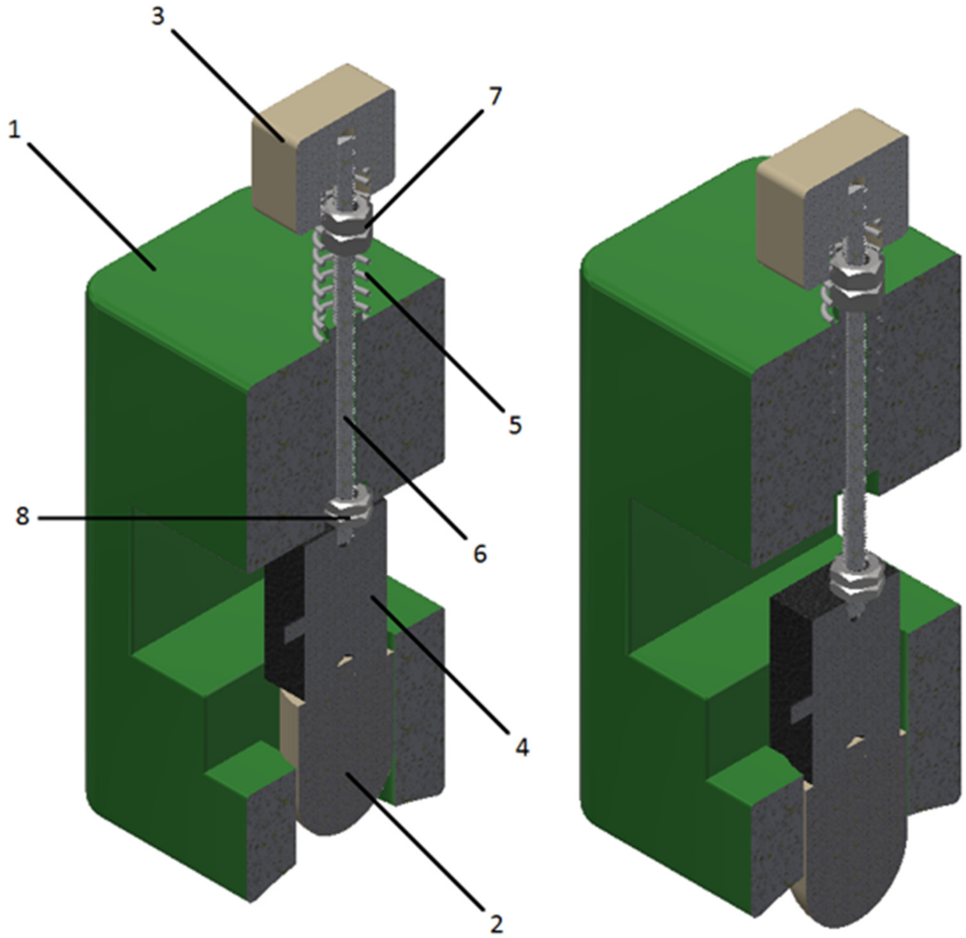

Fig. 1: 1 – body of the apparatus, 2 – indentor, 3 – push handle, 4 – sensor, 5 – spring, 6 – threaded rod, 7-8 – nuts

Fig. 1 provides an overall view of the myotonometer.

The measuring apparatus consists of apparatus body (Fig. 1 pos. 1), which is a complete supporting construction and a frame for linear reversible movement of the measuring apparatus, the indentor (Fig. 1 pos. 2) and the handle (Fig. 1 pos. 3). To produce these parts, we used the 3D printing method. The measuring apparatus includes a one-axis pressure sensor by Kisler 9317 (Fig. 1 pos. 4), threaded rod M6 (Fig. 1 pos. 6), nut for end-stops (Fig. 1 pos. 7 and 8) and the compression spring (Fig. 1 pos. 5) for reversible movement. To transfer the measured data to PC, the device is equipped with the connector, which is in the opening. The Sensor (Fig. 1 pos. 4) is located between the indentor and the threaded rod on which end is the handle (Fig. 1 pos. 3). Two pairs of nuts are placed on the threaded rod to define the start and stop position for the movement of the measuring system.

It can be seen from Fig. 2 that the apparatus has a surface applied to the measured muscle to by rounded to make better and truly large area have contact with muscle ant not compress locally examined tissue.

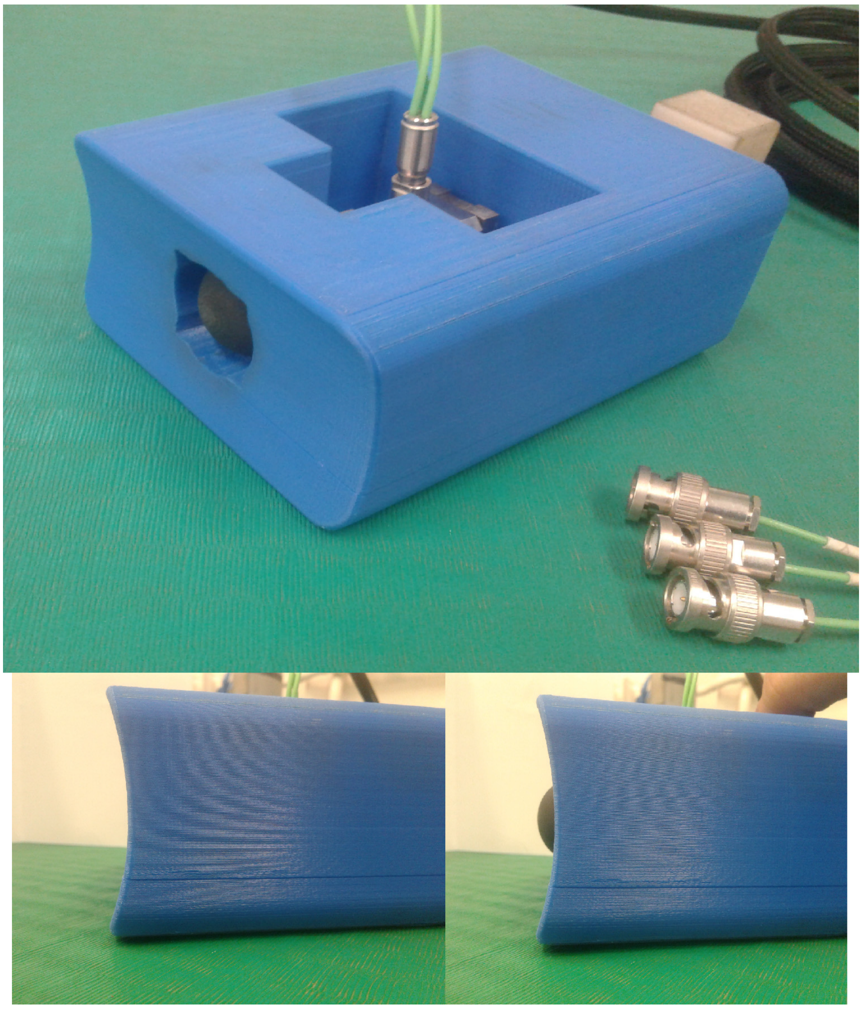

Fig. 2: Myotonometer

Actual used of our myotonometer:

The apparatus is currently used in the master thesis Bc. Miroslava Patschová, who examines the changes in tone of selected muscles after applying Foam roller immediately after physical performance. Fig. 3 is a control software environment showing a contact force measurement record.

Conclusion:

The purpose of the article was to show how beneficial the "engineering" approach can be when it is applied with respect to the industry of its immediate application. Within the scope of this article we presented apparatus, that despite its simplicity, it provides useful data. At the same time, the design provides practically unlimited possibilities for its expansion to measure other phenomena that are subject to more detailed research in muscle tissue. Currently, next generation of the device is under the development. It will offer a more ergonomic profile and a more comfortable setting of the depths for the indentation.