# Evaluation of Peak Force of a Manually Operated Chiropractic Adjusting Instrument With an Adapter for Use in Animals

Felipe Coutinho Kullmann Duarte, MS,[a] Carolina Kolberg, PhD,[a] Rodrigo R. Barros,[b] Vivian G.A. Silva, BS,[c] Günter Gehlen, PhD,[d] Jakson M. Vassoler, PhD,[e] and Wania A. Partata, PhD[f]

## Abstract

**Objective:** This study was designed to assess the peak force of a manually operated chiropractic adjusting instrument, the Activator Adjusting Instrument 4 (AAI 4), with an adapter for use in animals, which has a 3- to 4-fold smaller contact surface area than the original rubber tip.

**Methods:** Peak force was determined by thrusting the AAI 4 with the adapter or the original rubber tip onto a load cell. First, the AAI 4 was applied perpendicularly by a doctor of chiropractic onto the load cell. Then, the AAI 4 was fixed in a rigid framework and applied to the load cell. This procedure was done to prevent any load on the load cell before the thrust impulse. In 2 situations, trials were performed with the AAI 4 at all force settings (settings I, II, III, and IV, minimum to maximum, respectively). A total of 50 000 samples per second over a period of 3 seconds were collected.

**Results:** In 2 experimental protocols, the use of the adapter in the AAI 4 increased the peak force only with setting I. The new value was around 80% of the maximum value found for the AAI 4. Nevertheless, the peak force values of the AAI 4 with the adapter and with the original rubber tip in setting IV were similar.

**Conclusion:** The adapter effectively determines the maximum peak force value at force setting I of AAI 4. (J Manipulative Physiol Ther 2014;37:236-241)

**Key Indexing Terms:** *Chiropractic; Biomechanics; Manipulation, Spinal*

The use of chiropractic methods for treatment and prevention of changes in the musculoskeletal system has been increasing worldwide.[1-6] In chiropractic, there is an emphasis on manual treatments, such as vertebral manipulation with high velocity and low amplitude. However, techniques involving the use of instruments are also used, particularly the Activator Adjusting Instrument (AAI), a hand-operated device for applying mechanical force.[7-10] Although several mechanical instruments to apply force exist, the Activator Adjusting Instrument 4 (AAI 4) is considered to be the most popular of these instruments.[11]

The AAI 4 is a hand-operated and spring-loaded device designed for clinical use in human patients. This device is used for treating functional changes affecting the spinal column and other joints. It delivers a mechanical force or thrust to a patient's spine at a rapid speed and in a precise direction.[7-10,12-17] Of the 5 existing versions of the AAI, we

[a] Academic Researcher, Department of Physiology, Institute of Basic Health Science, Federal University of Rio Grande do Sul/UFRGS, Porto Alegre, Brazil.

[b] Technician, Department of Mechanical Engineering, School of Engineering, Federal University of Rio Grande do Sul, Porto Alegre, Brazil.

[c] Private Practice, Porto Alegre, Brazil.

[d] Professor, Chiropractic Graduation Program from Feevale University, Novo Hamburgo, Brazil.

[e] Professor and Academic Researcher, Department of Mechanical Engineering, School of Engineering, Federal University of Rio Grande do Sul, Porto Alegre, Brazil.

[f] Professor and Academic Researcher, Department of Physiology, Institute of Basic Health Science, Federal University of Rio Grande do Sul/UFRGS, Porto Alegre, Brazil.

Submit requests for reprints to: Felipe Coutinho Kullmann Duarte, BS(Chiro) Sarmento Leite, 500, Porto Alegre, Rio Grande do Sul, Brazil CEP 90050-170.
(e-mail: *felipe.quiropraxia@gmail.com*).

Paper submitted June 20, 2013; in revised form January 20, 2014; accepted February 25, 2014.

0161-4754



http://dx.doi.org/10.1016/j.jmpt.2014.02.004

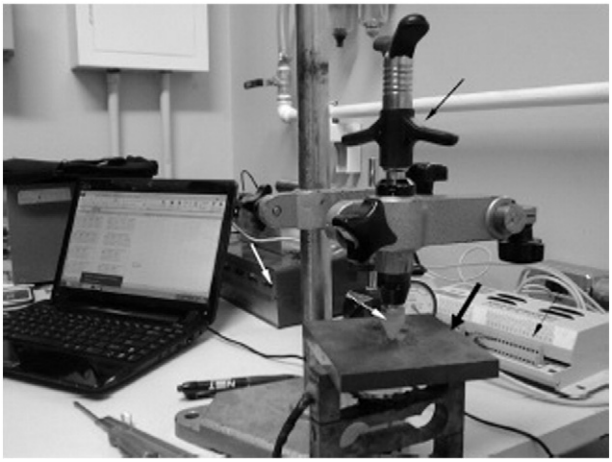

**Fig 1.** *Activator Adjusting Instrument 4 (narrow black arrow) with adapter (narrow white dotted arrow) attached rigidly to a framework that maintains the same position when thrusting. Note the load cell (wide black arrow), the converter (narrow black dotted arrow), and the signal conditioner (narrow white arrow) used to detect the peak force of the AAI 4 when this device was manually held and held by a fixed rigid arm.*

**Fig 2.** *Adapter of the AAI 4 developed for use in studies with animal models, which was used in AAI 4 that was manually held and held by a fixed rigid arm.*

used the fourth, the AAI 4 (Fig 1). This device possesses 4 (I, II, III, and IV) precision force settings, where I corresponds to the minimum force and IV to the maximum force. One advantage of its use is the application of a controlled force with less variability compared with vertebral manipulation.[8,9,11] Thus, the AAI may offer an advantage over manual adjustments for research studies that aim to demonstrate the physiological responses to high-velocity, very-low-amplitude thrusts.

Historically, animal models have been used experimentally to improve the understanding of several disorders such as cancer, diabetes mellitus, high blood pressure, and others as well as in research to develop new forms of treatment for a number of pathologic conditions.[18-21] The use of animal models in chiropractic has been growing and will certainly result in better understanding of the inherent mechanisms of the chiropractic treatment.[22-26] Animal models have also been used in studies that aim to demonstrate the physiological effects of the AAI.[5,13,27-29] A recent study showed that the use of AAI 4 improved mechanical sensitivity after immobilization of the right hind paw in rats.[30] However, this study used an adapter placed at the end of the AAI 4 that reduced the contact surface area of the device by around 4-fold.[30] The contact area was reduced because the rat has a mass approximately 350× smaller than a human weighing 70 kg. Nevertheless, the force exerted by the AAI 4 was concentrated in the small area of the adapter. It is possible that the force of the AAI 4 onto the animal was of greater magnitude.

Therefore, this study was designed to assess the peak force of a manually operated chiropractic adjusting instrument, the AAI 4, with an adapter for use in animals, which has a 3- to 4-fold smaller contact surface area than the original rubber tip.

## Methods

This study used a load cell to assess the peak force of the AAI 4 with an adapter and with the original rubber tip. First, the AAI 4 was applied perpendicularly by a doctor of chiropractic (DC) onto the load cell. Then, the AAI 4 was fixed in a rigid metal arm and applied perpendicularly onto the load cell. This last experimental step was carried out to prevent the effect of any load on the load cell before the thrust impulse. In 2 experimental protocols, the peak force of the AAI 4 was determined in its 4 force settings.

### Experimental Procedures

The investigation was carried out using the AAI 4 manufactured by Activator Methods International, Ltd (Phoenix, AZ). In the tests, the peak force values of the AAI 4 were determined at each of its force levels (I, II, III, and IV), with 2 different tips. The original tip was manufactured of silicone polymer, with a contact surface area of about 0.785 $cm^2$. The adapter (a gift from Trierweiler et al[30]—the same used in their study) (Figs 1 and 2) was made of nylon, with a contact surface area one-fourth of the original (0.196 $cm^2$), and has 25% of the total area of the original tip.

For determination of peak force values, we used a load cell of the "S" type, with 30 kgf capacity (Fig 1), manufactured by the Grupo de Mecânica Aplicada (Department of Mechanical Engineering, School of Engineering, Federal University of Rio Grande do Sul, Brazil).

For the tests, the load cell was mounted rigidly on a table, and the AAI 4 was thrust perpendicularly onto it (Fig 1). Data for the load cell were collected by a 16-bit analog converter (USB1608HS2AO; Measurement Computing, Norton, MA) connected to a signal conditioner with 5 inputs (manufactured