EXPERIMENTAL RESEARCH ABOUT THE FUNCTIONING CYCLES OF THE SEAT CUSHION, DRIVEN BY PNEUMATIC MUSCLES

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Abstract. *By experimental measurements, the paper aims to test the functioning of the dynamic type pillow during loading and unloading cycles and the ability to support various weight categories. By successive feeds pressure of 3 bar and 4 bar and with a sample weight load of 10 kg up to 70 kg, the influence of the loads on the elasticity of the pneumatic muscles is achieved and by the interface pressure values achieved between the user and the device. After using the device dynamically the air consumption is optimizes itself in terms of ergonomics, user weighing 60 kg, 80 kg, 100 kg. Through experimental research examining whether progressively increasing pressure device provides the ability to determine superficial skin massage with a role to oxygenate tissues, stimulate blood circulation and ventilation to the pelvic area between the user and the device.*

Keywords: *pneumatic muscle, seat cushion, pressure ulcers, interface pressure*

1. INTRODUCTION

Pressure ulcers remain a common complication of health care, despite intense prevention strategies. In addition to patient pain and discomfort, there is a risk of developing further complications like infection that can lead to death. It is known that a significant proportion of pressure ulcers occur in patients bedridden, and thus dependent on the use of medical devices [1]. They can not always be avoided and require new techniques to help reduce or prevent damage to skin care subdevice. Pressure ulcers occur in all age groups and at all stages of care. Frequency is described in detail at the local level in the specialty [2], [3] and at the inte.

The first and the most popular theory is that prolonged subjection to pressure causing tissue damage due to capillary damage, leading then to lack of oxygenation of the skin and tissues [5], [6], [7].Localized direct pressure causes damage to the skin and soft tissues, which creates tension and shear forces around prominent areas [8].

When the soft tissue is compressed between the projection area and a hard surface, resulting in a higher pressure than the pressure of irrigation, sensitivity occurs. If the pressure is not released and remains a longer period of time, tissue necrosis. Prolonged pressure causes soft tissue damage to near bone. Answer healthy body at a constant pressure, is the change of position, so that the pressure to redistribute. This answer is the result of a high temporary supply of blood to a surface, replacing the toxic substances and by providing oxygen and nutrients [9].

II EXPERIMENTAL DETERMINATION OF THE FUNCTIONING CYCLES FOR THE SEAT CUSHION, ACTUATED BY PNEUMATIC MUSCLES

In order to determine the dynamic operation of the cushion type, operated by pneumatic muscles were carried out using a sample weight subsequent load of 10 kg to 70 kg. Measurements were made for feeding pressure of 3 bar and 4 bar.

In order to determine the minimum or maximum race of the device, the supply air, we use weights equal weight to 10 kilograms force, with a circular shape and a diameter of 20 cm. We chose this type of weight because weight is evenly distributed, and determinations will be made with precision.As a preliminary stage, as shown in Figure 1, in order to prevent the development elastic pneumatic muscles to influence the recording of data, we used a plate on which sat a dynamic device.

The plate rigidities, avoid when the device is powered pressure weights to alter the position and the danger that they move out of the circle that is drawn as a reference plate.

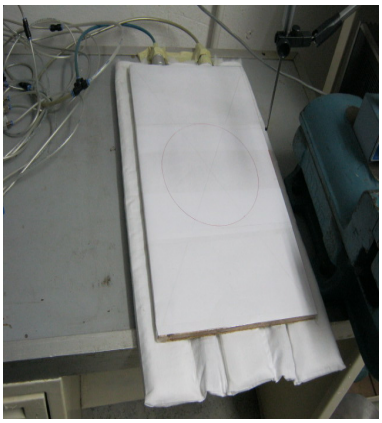


Figure 1 - Plate dynamically placed on device

Using the dial gauge were reading races they carry maximum pneumatic muscles. To determine the repeatability of the values recorded by pneumatic muscles in loading and unloading cycles, the measurements presented show were considered for each weight five cycles.

The figures below describes how the experimental measurements are made. The device supports a weight of 10 kg and is fed to the pressure of 3 bar. Make five cycles, the maximum values are read. Perform

determinations of duty cycles and weights 20 kg, 30 kg, 40 kg, 50kg, 60 kg, 70 kg. The same steps are followed when the device is powered with 4 bar.

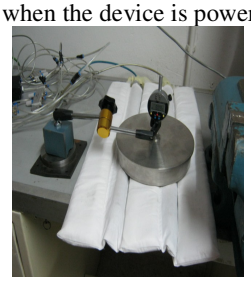


Figure 2 – Loading the device with 10 kg

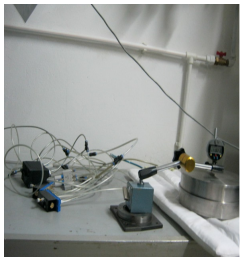


Figure 3 – Loading the device with 20 kg

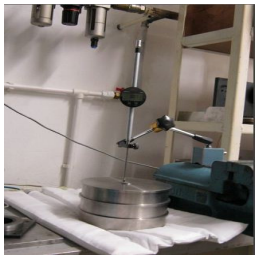


Figure 4 – Loading the device with 30 kg

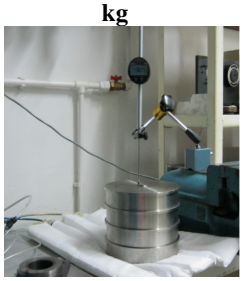


Figure 5 – Loading the device with 40 kg

Figure 6 – Loading the device with 50 kg

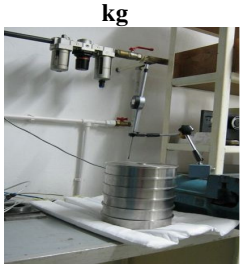
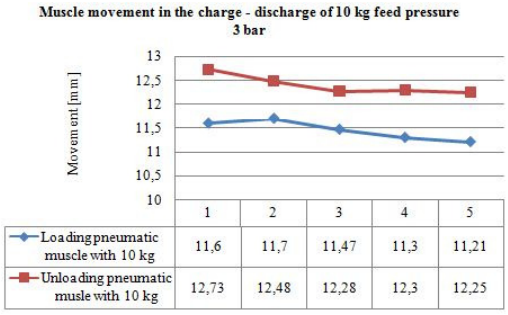


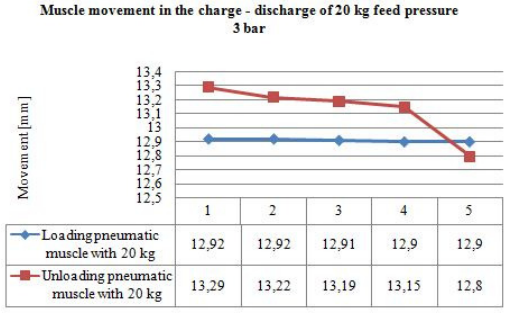
Figure 7 – Loading the device with 60 kg

Figure 8 – Loading the device with 70 kg



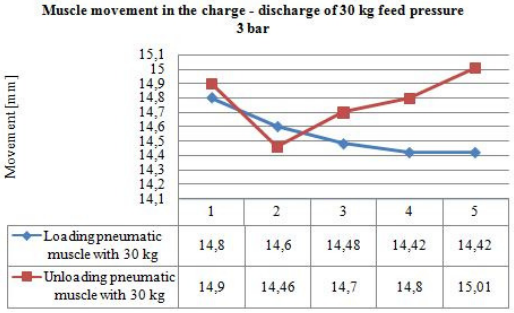
	1	2	3	4	5
Loading pneumatic muscle with 10 kg	11,6	11,7	11,47	11,3	11,21
Unloading pneumatic musle with 10 kg	12,73	12,48	12,28	12,3	12,25

Figure 9 - Muscle movement in the charge - discharge of 10 kg feed pressure 3 bar



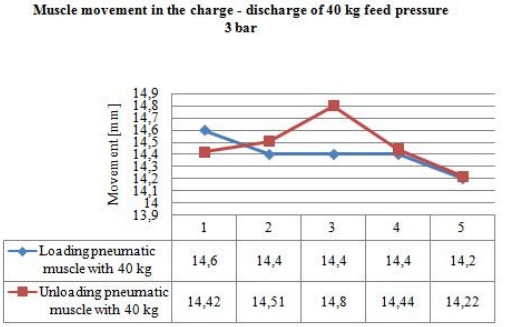
	1	2	3	4	5
Loading pneumatic muscle with 20 kg	12,92	12,92	12,91	12,9	12,9
Unloading pneumatic muscle with 20 kg	13,29	13,22	13,19	13,15	12,8

Figure 10 - Muscle movement in the charge - discharge of 20 kg feed pressure 3 bar



	1	2	3	4	5
Loading pneumatic muscle with 30 kg	14,8	14,6	14,48	14,42	14,42
Unloading pneumatic muscle with 30 kg	14,9	14,46	14,7	14,8	15,01

Figure 11 - Muscle movement in the charge - discharge of 30 kg feed pressure 3 bar



	1	2	3	4	5
Loading pneumatic muscle with 40 kg	14,6	14,4	14,4	14,4	14,2
Unloading pneumatic muscle with 40 kg	14,42	14,51	14,8	14,44	14,22

Figure 12 - Muscle movement in the charge - discharge of 40 kg feed pressure 3 bar

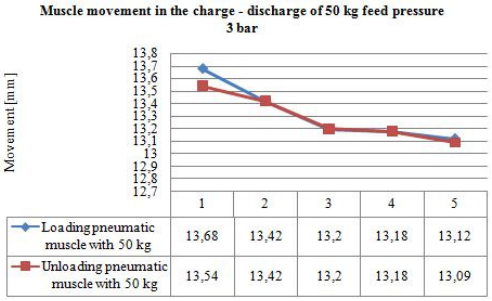


Figure 13 - Muscle movement in the charge - discharge of 50 kg feed pressure 3 bar

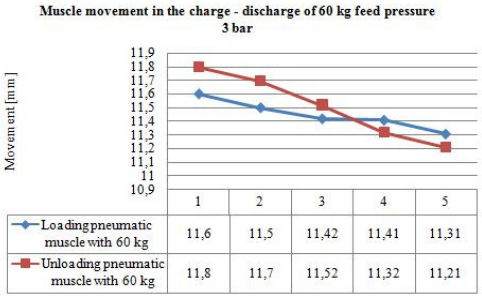


Figure 14 - Muscle movement in the charge - discharge of 60 kg feed pressure 3 bar

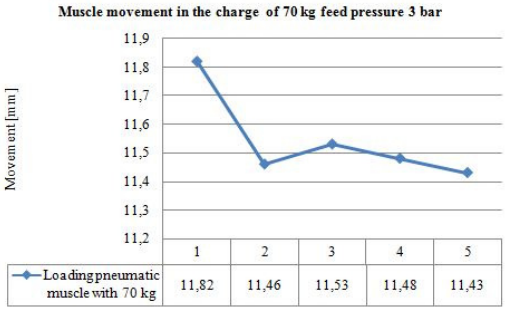


Figure 15 - Muscle movement in the charge of 70 kg feed pressure 3 bar

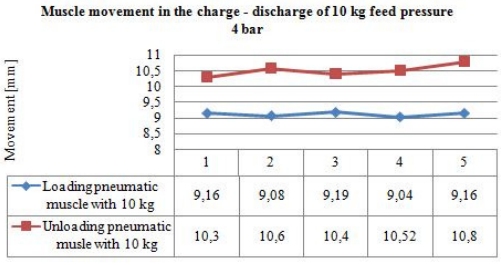


Figure 16 - Muscle movement in the charge - discharge of 10 kg feed pressure 4 bar

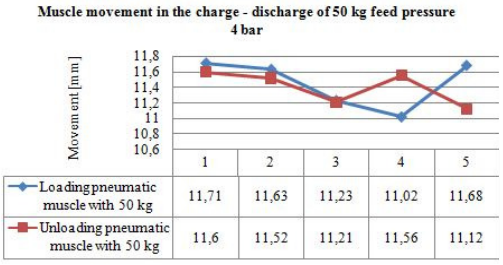


Figure 20 - Muscle movement in the charge - discharge of 50 kg feed pressure 4 bar

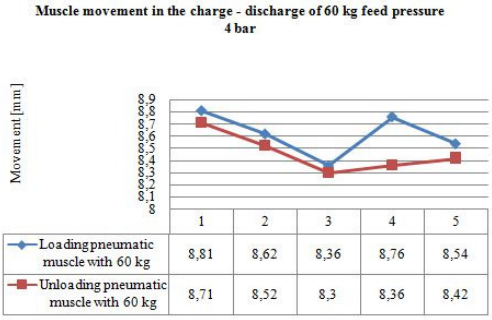


Figure 21 - Muscle movement in the charge - discharge of 60 kg feed pressure 4 bar

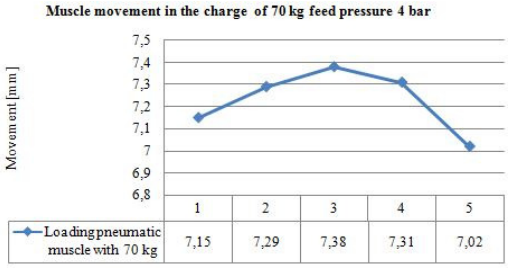


Figure 22 - Muscle movement in the charge of 70 kg feed pressure 4 bar

According to data contained in graphic form, it is found that the material they are made of pneumatic muscles, rubber, influence the evolution of these races made when supplied with air.

Thus, when the pneumatic muscles are loaded with weights from 10 kg, 20 kg, evolution is a clear hysteresis as the influence weights, muscle elasticity determines the different weights can cause a complete draining of the air inside the muscle membrane Pneumatic.

When dynamic device type pillow is loaded with weights of 30 kg, namely 40 kg, 50 kg, 60 kg, power, maximum recorded races pneumatic muscles, is not much different because the action is determined weights complete drainage the air inside the membrane pneumatic muscles.When dynamic device type pillow is loaded 70 kg and pressure of 3 bar fed, maximum racing developments tend to stabilize, and the values are close to those that were determined when the device is loaded with weight of 60 kg.

III RESEARCH ON DETERMINATION OF THE INTERFACE PRESSURE CONTACT BETWEEN THE USER AND THE SEAT CUSHION

To demonstrate the use of dynamic device driven by pneumatic muscles pillow type does not lead to increased pressure sores by progressive degradation of skin integrity, based on experimental data obtained by mathematical calculation will determine the pressure value recorded interface between user and device.
User is equated with the weight that has been placed on dynamic device as follows: 10 kg, 20 kg, 30 kg, 40 kg, 50 kg, 60 kg, 70 kg. Calculation of interface pressure is determined for racing that made the inlet pressure of 3 bar and 4 bar.The calculation of the interface pressure of 10 kg weight

m = 10 kg

$$P = \frac{m \times g}{S} \quad (1)$$

L=180 mm

l=11,45 mm

$$P = \frac{m \times g}{S} = \frac{10\,kg \times 10}{2 \times 0.18 \times 0.01145} = \frac{50}{0.18 \times 0.01145} = \frac{50}{0.002061} = 24260.06\,N/m^2 \quad (2)$$

$$24260.06 \frac{N}{m^2} \times 0.0075 mmHg = 181.95\ mmHg \quad (3)$$

Table 3.1– Interface pressure contact between the user and the seat cushion, when the pneumatic muscles supplied at 3 bar

No.	Weight [kg]	Interface pressure [mmHg]	Interface peak pressure [mmHg]
1	10	181,95	9,57
2	20	323,27	17,01
3	30	432,69	22,77
4	40	600	31,57
5	50	781,25	41,11
6	60	1097,56	57,76
7	70	1268,11	66,76

Table 3.2 – Interface pressure contact between the user and the seat cushion, when the pneumatic muscles supplied at 4 bar

No.	Weight [kg]	Interface pressure [mmHg]	Interface peak pressure [mmHg]
1	10	234,37	12,33
2	20	416,66	21,92
3	30	511,36	26,91
4	40	652,17	34,32
5	50	937,50	49,34
6	60	1607,14	84,58
7	70	2019,27	106,27

Blood pressure increases physiological exercise, strong emotional states in sleep and dreams differ from sex to sex, age and the elderly. It falls during quiet sleep. Pathological increase in cases of fever or hypertension. The normal values are 100-130 mmHg for men and 90-120 mmHg for women [6].

IV DETERMINATION OF ERGONOMICS OF THE DYNAMIC SEAT CUSHION USING 60 KG, 80 KG, 100 KG

In addition to the functionality of the device is intended to Dermine character ergonomic cushion for weight categories set. Following these determinations will draw conclusions and new research directions, to improve the device.
It will also determine that the users feel the pressure to the device to be beneficial and the point where it becomes uncomfortable.In order to determine this purpose, the device is used repeatedly operated during 20 minutes on a continuous basis.The degree ergonomic device to be determined for successive feeds pressure of 1 bar, 2 bar, 3 bar 4 bar 5 bar.In determining the ergonomics of the device, the user uses the pillow 60 kg feed pressure of 1 bar for 20 minutes. Similar to proceed and pressure of 2 bar 3 bar 4 bar 5 bar. The results are listed in tabular form, and then conclusions are drawn.Was chosen as the user continuously for 20 minutes as it is desired to avoid overheating of the compressor to the air for long periods.

Tabele 4.1 – The results of ergonomics for 60 kg user

No.	Pressure [bar]	Observations
1	1	Filling muscles are slowly User resim a gentle massage.After 5 minutes, the step used to the power of the device, and the massage it feels sluggish.
2	2	Filling muscle is faster than the supply phase 1 bar. Switching pressure of 1 bar to 2 bar the felt easily. Frequency of low power cycles.
3	3	User notes throughout the use of the device, the feeling of comfort and massage lightly. The difference between the stages of the supply pressure is noticeable.
4	4	Power Cycle rate is increasing, massage it feels rough.
5	5	Discomfort after the first few minutes of use
General observation		The user weight of 60 kg appreciated that the degree of comfort of the device in use, there is the supply pressure of 2 bar. The user raises enough so that the vent seat.Feeling of comfort is affected by gravity and the pressure in the power supply

Table 4.2 – The results of ergonomics for a 80 kg user

No.	Pressure [bar]	Observations
1	1	Filling muscles are slowly User resim a gentle massage.After 5 minutes, the step used to the power of the device, and the massage it feels sluggish.For too long compression are easily stiff muscles.
2	2	Filling muscle is faster than the supply phase 1 bar. Switching pressure of 1 bar to 2 bar feels the slightly forced. Frequency of low power cycles.
3	3	User notes that during the contraction is shorter and higher frequency.User notes throughout the use of the device, the feeling of comfort and massage Shallow. Massage is felt on a larger area.
4	4	Power Cycle rate is increasing, the user feels as tough muscle action.
5	5	Discomfort after the first few minutes of use
General observation		The user weight of 80 kg appreciated that the fence comfort of the device in use, there is the supply pressure of 3 bar. The user raises enough so that the vent seat.Weight ergonomic user determines the threshold of the device.The user is specifying that in the event of a much thicker layer of material intermediate zone massage would feel more comfortable and at a higher pressure.

Table 4.3 – The results of ergonomics for a 100 kg user

No.	Pressure [bar]	Observations
1	1	Filling muscles are slowly User resim a gentle massage.After 5 minutes, the step used to the power of the device, and the massage it feels sluggish.Compression too long.
2	2	Filling muscle is faster than the supply phase 1 bar. Switching pressure of 1 bar to 2 bar that is noticeable. Frequency of low power cycles.
3	3	User notes that during the contraction is shorter and higher frequency.User notes throughout the use of the device, the feeling of comfort and massage Shallow.Alternative cycles of loading - unloading, ensure lifting of all pelvic area.
4	4	Power Cycle rate is increasing, the user feels as tough muscle action.
5	5	Discomfort after the first few minutes of use
General observation		User weight of 100 kg appreciated that the fence comfort of the device in use, there is the supply pressure of 3 bar. The user raises enough so that the vent seat.The user is specifying that in the event of a much thicker layer of material intermediate zone massage would feel more comfortable and at a higher pressure.

V. CONCLUSIONS

According to experimental data, we demonstrated that dynamic device type pillow may be subject to a variety of body weight, while retaining completeness and properties.Interface pressure values recorded point is minimal, which means that when using the device does not aggravate the skin's appearance but provide a superficial massage the skin, oxygenating tissues and stimulating blood circulation and also ventilation pelvic area between the user and the device.

Degree ergonomic device was determined by actual use of the cushion.

After testing the device by selected users, we find that for each weight category, the level of comfort is different.as follows:

- a user weight of 60 kg chooses optimal supply pressure, 2 bar;
- a user weight of 80 kg chooses optimal supply pressure, 3 bar;
- a user weight of 100 kg chooses optimal supply pressure, 3 bar;

As a conclusion and future research direction, record user perception towards fur antiescară interlayer ie improving comfort desired by adding furry antiescară which will act to reduce the discomfort as much state registered pressures higher than those established after use.

ACKNOWLEDGMENTS

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