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Ideas and Innovations

Simple device to determine the pressure applied by pressure clips for the treatment of earlobe keloids

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ABSTRACT

Background: Keloids of the ear are common problems. Various treatment modalities are available for the treatment of ear keloids. Surgical excision with intralesional steroid injection along with compression therapy has the least recurrence rate. Various types of devices are available for pressure therapy. Pressure applied by these devices is uncontrolled and is associated with the risk of pressure necrosis. We describe here a simple and easy to use device to measure pressure applied by these clips for better outcome. **Objectives:** To devise a simple method to measure the pressure applied by various pressure clips used in ear keloid pressure therapy. **Materials and Methods:** By using a force sensitive resistor (FSR), the pressure applied gets converted into voltage using electrical wires, resistors, capacitors, converter, amplifier, diode, nine-volt (9V) cadmium battery and the voltage is measured using a multimeter. The measured voltage is then converted into pressure using pressure voltage graph that depicts the actual pressure applied by the pressure clip. **Results:** The pressure applied by different clips was variable. The spring clips were adjustable by slight variation in the design whereas the pressure applied by binder clips and magnet discs was not adjustable. **Conclusion:** The uncontrolled/suboptimal pressure applied by certain pressure clips can be monitored to provide optimal pressure therapy in ear keloid for better outcome.

KEY WORDS

Clips; device; earlobe; magnetic discs; measure; pressure therapy; splint

INTRODUCTION

Ear piercing is practiced from ancient times. Ear piercing is frequently associated with keloid formation.[1] Various treatment modalities have been described for ear keloid.[2] Pressure therapy following surgical excision and intralesional steroid injection has the least recurrence rate. Pressure can be applied on the ear by various methods using spring clips, binder clips and magnet discs but the pressure applied by these devices is

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not monitored and can cause suboptimal or uncontrolled excessive pressure leading to skin necrosis. We describe a simple device to measure the pressure applied by these clips for optimal compression therapy.

Device design and operation

We have devised an instrument [Figure 1] with the help of our Bioengineering Department using the following components: Force sensitive resistor (FSR), electrical wires, resistors, capacitors, converter, amplifier, diode, nine-volt (9V) cadmium battery and a multimeter.

For the assessment of pressure, the sensor has to be compatible and non-invasive to the human body as the sensor will be applied on the ear along with the pressure clips. We chose the force sensitive resistor (FSR 402-Probots Techno Solutions, Bangalore, India) for assessing the pressure applied by the pressure clips on the earlobe. The sensors have 12.7 mm round sensing area which can be used to detect any force or pressure applied on them. FSR is a thick polymer film device which senses the change in resistance based on the force applied on it. The active area of FSR detects the force applied over it. So, to measure the pressure between the heads of a clip, FSR needs to be placed in between the heads of the clip on earlobe [Figure 2].

When the clip closes, it applies force over the active area of FSR and this is reflected as a change in resistance across its leads.

Let resistance of FSR be R_{fsr}, then Force α $1/R_{fsr}$

Pressure = Force/Area, hence pressure α $1/R_{fsr}$

The FSR has two output wires. The signal is transmitted to the circuit of the device in order to detect the force applied. The circuit works on a 9V battery and using a voltage converter it gives-9V output. This voltage is used as supply voltage and a Zener diode is used to give constant 5V output (V_{ref}). The final section of the circuit converts force applied to output voltage (V_{out}) which is measured using a multimeter.

The voltage developed is directly proportional to the force applied at the FSR. The voltage detected is then converted to pressure in millimetres of mercury (mm of Hg) using pressure voltage graph as shown in Figure 3.

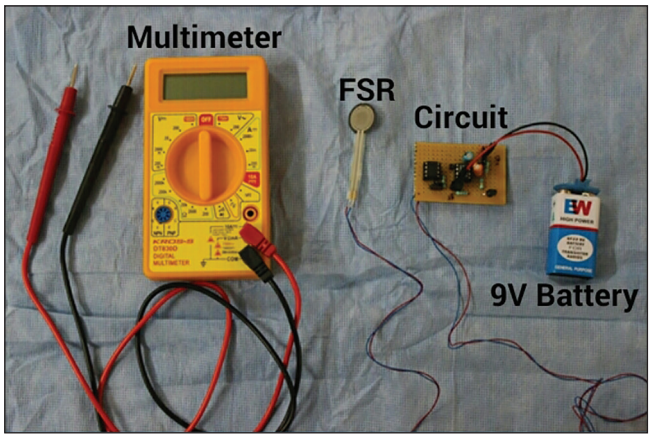

Figure 1: Device and its components

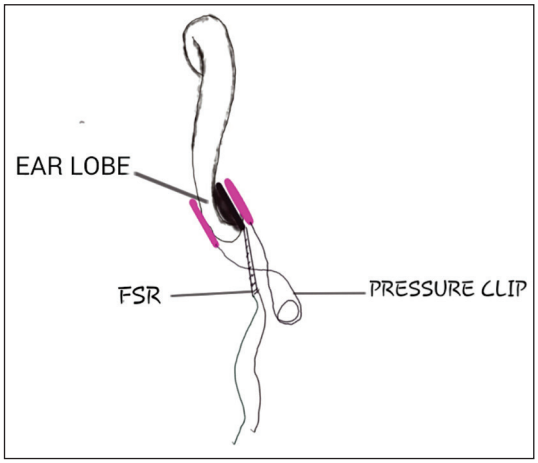

Figure 2: Ear clip applied on earlobe with FSR to measure pressure

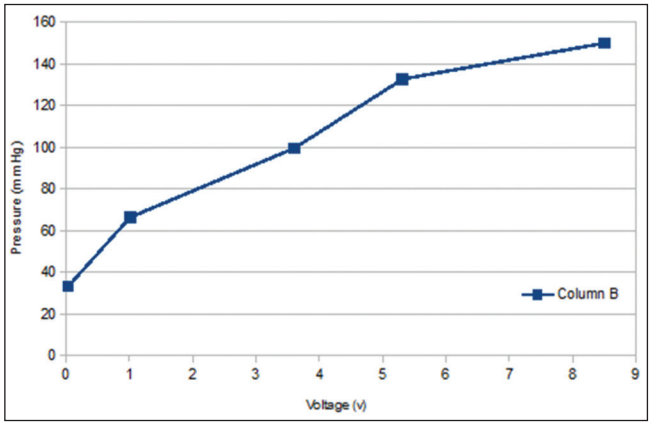

Figure 3: Pressure voltage graph

The pressure clips used in the study were spring clips and magnetic discs. The clips with spring action were customised using 20 G dental wire, acrylic buttons, and binder clips (15 mm, 19 mm and 25 mm). The magnetic discs of sizes 12 mm × 2 mm and 10 mm × 1.5 mm were also used. We used this device and measured the pressure applied by various clips and magnet discs on the ear and the findings were noted.

RESULTS

The pressure applied by these ear clips varied and the findings are tabulated in Table 1. The pressure applied by certain clips such as binder clips and magnetic discs was not adjustable, whereas with spring clip 1, pressure could be adjusted by changing the width of U loop in between the limbs. By narrowing the width, the pressure applied between the clip heads could be increased.[3] Using spring clips 2 and 3 the pressure could be adjusted according to the memory of the coil/turn of wires. The tensile strength of the wire used also affects the pressure applied by the clip. The force distributed on the FSR may not be uniform and, on assessment, it was found to have 20% deviation from the normal value, mostly the deviation was towards higher end and that has been considered while interpreting the results.

DISCUSSION

Pressure therapy is a widely practiced method for the prevention and treatment of hypertrophic scar and keloid. Although there is no consensus regarding optimal pressure to be applied, the majority recommend pressure in the range of 24-35 mm of Hg for good outcome. Pressure therapy on ear is difficult due to its peculiar shape. An efficient compression device should provide calibrated uniform compression. Many pressure devices have been described for ear, including button compression,[4] oyster splint,[5] cloth clip,[6] silicone mould,[7] compression using spring clips,[3,8,9] binder clips[10] and magnetic discs.[11,12] The use of binder clips and cloth clips forced us to think whether these clips apply much more pressure than the recommended range.

Table 1: Values of pressure applied by various clips and after deduction of 20% error

Types of pressure clips		*Pressure*	*Pressure after 20% error correction*
Spring clips 1		25-35 mm of Hg	20-28 mm of Hg
Spring clips 2		30-40 mm of Hg	24-32 mm of Hg
Spring clips 3		35-50 mm of Hg	28-40 mm of Hg
Binder clips		55-70 mm of Hg	44-56 mm of Hg
Magnetic discs (10 mm 12 mm)		30 mm of Hg 40 mm of Hg	24 mm of Hg and 32 mm of Hg

In all splints, excessive pressure is judged by subjective symptoms such as pain, numbness and redness and it depends on patient's intelligence. This method is an objective method of measurement. This study showed that spring clips are better than binder clips. Out of the three spring clips, type I spring clip was the best. The use of binder clips should be discouraged. Magnets are safe if they are of correct size and strength. Considering that this device has 20% error towards the higher side, we calibrate spring clip for 35 mm of Hg.

Recently, there has been an increase in the application of magnet discs for pressure therapy on the ear. Magnets are available in different power, size and thickness. The force applied by the magnets can also be assessed using gauss meter and pressure can be determined using simple conversion,[13] although this device is costly and not used frequently. The presently available magnets are neodymium magnets. Chang *et al*.[11] have described the use of magnet discs of 10mm (1,100 gauss) and 12 mm (1,700 gauss) size with pressure of 35 mm of Hg. Our device had few disadvantages as mentioned below:

Measurement of pressure depends upon the area across which the force is applied; it has 20% error towards the higher side.Repeatability of measurement depends on the region on which the force is applied.The response time for the system is high.

CONCLUSION

The currently available pressure devices for ear keloids can exert uncontrolled pressure over and above the recommended pressure. Too much pressure may be indicated by pain sensation but this is subjective and it depends upon the patient's intelligence. Certain pressure clips, such as binder clips and cloth clips, should be avoided as they cause uncontrolled pressure which cannot be adjusted. So, it is always better to assess the pressure applied by these clips before using them. Our simple and easy to use device can be used to measure the pressure applied by these clips before their application, and the over-the-counter availability of the device would make things easier for most of the plastic surgeons who do not have the resources to have such an instrument made.

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Conflicts of interest

There are no conflicts of interest.

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