

# INFLATABLE, VERSATILE, MULTI-PURPOSE RETRACTOR FOR ABDOMINAL SURGERY

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## I. ABSTRACT

A self-retaining retractor is used widely in abdominal surgeries. It holds back the underlying tissues and organs so that the incision may be accessed. The self-retaining retractor enhances the performance of abdominal surgeries as second assistant is not required at the operating table providing more freedom of movement to the surgeon. It also reduces the risk of surgical site infections to a great extent.

***Keywords—self-retaining retractor; abdominal wall; caesarean section; surgical site infection; intraoperative damage; tamponade effect;***

## II. INTRODUCTION

At times a second assistant may not be available, and even if one is present, one must hold the instrument against an unyielding rib cage. This quasi-static position cannot be maintained for too long an interval and as a consequence, frequent annoying shifting of the appliance results. Also, especially in obese patients, the relatively short arms of the retractor do not permit adequate visualization in the depths of the wound.

Self-retaining retractor permits surgery to proceed without the presence of second assistants, allowing for less crowding at the operating table. This device frees the assistants from retractor holding chores and instead makes them available for other jobs such as aid in exposure, homeostasis, closure, and other intra-operative technical functions that help the surgeon

Among the types of retractors are metal type and plastic sheath type retractors. In metal retractors, stainless steel is generally used for retraction as it is strongest material and can be sterilized and reused. The plastic sheath retractors are used both as effective retractors as well as wound protectors. The advantages of self-retaining retractors are continuous adequate exposure, decreased risk of infection, lessened number of assistants with increased efficiency as the concentration will now be on the surgery rather on the retraction.

### III. METHODOLOGY

The retractor comprises of a plastic sheath and two rings: inner ring and outer ring. The rings are inflatable and can be inflated or deflated according to the requirement with the help of an air bulb. Two 3-way stop cock are used to connect the inner ring, outer ring, and sphygmomanometer and air bulb.

Both the rings consist of an inflatable member which is adjustable to radial dimensions. Fig.1 is a view of the device in deflated state. This is the contracted state of the device.



Fig.1: Retractor in deflated position before incision into cavity.

The inflatable members are inflated one by one with the help of stopcock. The air bulb is pressed repeatedly until the inflatable member is inflated. Firstly, the direction of stop cock is aligned in such a way that it connects the inner ring and the air bulb. The inner ring is inflated by pressing the air bulb repeatedly. The maximum amount of air that is to be filled in inner ring is checked by sphygmomanometer. Fig.2 shows the inner ring of the device in inflated position.



Fig.2: Inner member in inflated position

Once the inner ring is inflated, the direction of the 3-way stop cock is altered in such a way that it now connects the outer ring and the air bulb. Thus, the outer ring is inflated by pressing the air bulb repeatedly. The maximum amount of air to be filled in outer ring can also be checked by sphygmomanometer. Fig.3 shows the device in the position where both the members are inflated.



Fig.3: Both members in inflated position

This is the expanded state of the device. The radial dimension of the rings in expanded state is significantly larger than that of the contracted state.

After inflation, the outer ring is twisted outwards in order to create tension in the plastic sheath. As the inner ring inflates and plastic sheath gets tensed, underlying tissues and organs are pushed sideways.

The inflatable member is made up of flexible type material such as rubber. Balloons made up of Polyisoprene material can be used as inflatable member. They are resilient in nature. Thus, they return to their original shape when deflated.

The plastic sheath provides protection of wound along with retraction. The underlying tissues and organs may get harmed by other surgical devices used by surgeons. The sheath protects the organs and tissues from getting damaged. Thus sheath acts as wound protector.

To remove the device from surgical site, it is necessary to change the state of the device from expanded state to contracted state. The inflatable members of the inner ring and the outer ring are deflated respectively by releasing the pressure of air bulb. After deflation, the device can be easily removed from the incision site.

#### IV. EXPERIMENTAL SETUP

The task of retraction is accomplished by inflating the rings which expands the radial dimensions of the rings and increases the tension in plastic sheath. The retractor exerts force on the neighbouring walls in order to retract the neighbouring tissues and organs. The amount of force exerting on the adjacent walls is measured using Force Sensitive Resistive (FSR) sensor.

As the amount of force applied on FSR sensor increases, the resistance decreases and vice-versa. The maximum range of the FSR sensor is 0.1N to 10N. When there is no pressure applied on the sheath, the value of maximum resistance is 1M $\Omega$ . When the maximum pressure is applied, the resistance reduces to 2.5K $\Omega$ . Fig.1 shows the entire circuit for force measurement.

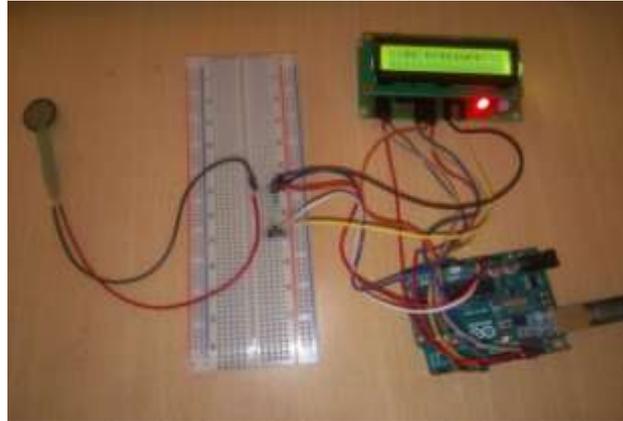


Fig.4: Force measurement circuit

LCD is interfaced with Arduino. Fig. 5 and Fig.6 depicts the device displaying the amount of force exerted by the retractor on the neighbouring area.



Fig.5: Device showing zero pressure

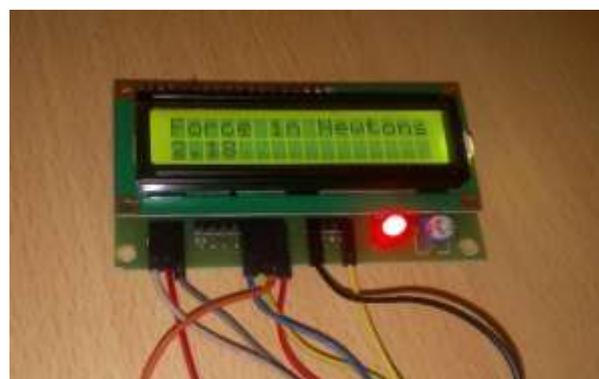


Fig.6: Device showing force exerted by sheath

The retractor may also damage renal vein causing renal vein thrombosis in which formation of clot occurs in the vein that drains blood from the kidneys, ultimately leading to a reduction in the drainage of one or both kidneys and the possible migration of the clot to other parts of the body.

## V. RESULT AND ANALYSIS

A bucket of sand is used as a sample and the amount of force exerted by the retractor on sand is measured. The FSR sensor is placed on the inner side of the plastic sheath and is connected to Arduino circuit interfaced with LCD for display.

The inflatable rings when inflated applies force on the adjacent organs. The maximum amount of air that can be filled in the rings is measured by using the sphygmomanometer. The pressure in the inflatable ring is proportional to the force exerted by the plastic sheath. Table I. depicts various position of the inflatable member, pressure in the inflatable member measured by sphygmomanometer, and the force exerted by sheath on neighbouring walls.

TABLE I. FORCE EXERTED BY INFLATING RINGS

Position of inflatable ring	Pressure in the inflatable ring (mm Hg)	Force exerted by sheath (Newton)
Deflated	0	0
Partially filled	110	0.34
Fully filled	130	0.53

As the rings are inflated, the amount of pressure in the rings is increased and thus the amount of force exerted by the rings on adjacent organs is increased.

The force exerted by the inflatable retractor is compared with the force exerted by the non-inflatable sheath retractor which comprises of a plastic sheath with two flexible rings on both of its ends. Table II. shows the comparison of force between inflatable and non-inflatable retractor.

TABLE II. COMPARISON OF RETRACTORS

Position of Retractor	Force in Newton	
	<i>Inflatable Retractor</i>	<i>Non-Inflatable Retractor</i>
Inner ring inflated	0.54	0.05
Both rings inflated	0.68	

Position of Retractor	Force in Newton	
	<i>Inflatable Retractor</i>	<i>Non-Inflatable Retractor</i>
Outer ring twisted	1.21	0.41

From the Table II, it is concluded that the inflatable retractor exerts comparatively more force on the adjacent walls. The inflatable retractor, thus, retracts the organs and tissues in an efficient manner, eradicating the need of hand-held retractors.

## VI. ADVANTAGES OF INFLATABLE RETRACTORS

The method of retraction plays a vital role in the risk of infection at the surgical site. An infection can occur at the site of surgery due to the use of retractors. Sepsis is a major reason of mortality.

Inflatable retractors reduce surgical site infections in many ways.

These retractors cover the tissues intra-operatively and thus prevent healthy tissues from getting contaminated by blood, fetal tissues, microorganisms and other surgical manipulations. Also it attributes to temponade effect which results in lesser amount of bleeding and better hemostasis. Since bleeding is less, therefore, the need of electrocautery for blood stoppage is limited [1].

The inflatable retractor enables wide exposure, and applies uniform retraction on the abdominal wall. Along with reducing the risk of infection, the inflatable retractors have various advantages over the metal retractors. They are as follows-

- There is a need for continuous suction and removing out the blood clots with the metal retractors. Since the plastic sheath retractors covers the surrounding walls, therefore, there is less blood loss and thus reduction in the need of suction during the operation.
- There is a reduction in the need for diathermy. Less use of diathermy leads to less infarcted tissues and debris.
- It is easy to use and remove the retractor.
- The metal retractors may produce asymmetrical and sometimes excessive traction. This may result in hematomas and postoperative pain. This postoperative pain is reduced to a great extent with the plastic retractor, thus, reducing the morphine intake [3].
- There is better exposure and fewer crowds at the operating table. This provides the surgeon with more freedom of movement at the operating table.
- Morbidity is less.
- Feasible, safe and efficient technique.
- They are disposable.

- They significantly reduce post-operative ileus i.e., less abdominal cramps, nausea, bloating, vomiting and constipation.
- They also reduce time to return to normal diet, ICU and overall hospital stay.
- Facilitates earlier return to normal diet and proper bowel functions [11].

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