A Project Report

On

**Neuroendoscope Holder and Brain Retractor**

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(2012BMZ8116)



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### October 2012

**Neuroendoscopy**

* Neuroendoscopy is a minimally-invasive surgical procedure in which the neurosurgeon removes the tumor through small holes in the skull or through the mouth or nose.

Neuroendoscopy enables neurosurgeons to:

* Access areas of the brain that cannot be reached with traditional surgery
* Remove the tumor without cutting or harming other parts of the skull

Neuroendoscopy results in:

* Less pain than traditional surgery
* Faster recovery than traditional surgery
* Minimal scarring

The neurosurgeon can see into the brain to an extent that was not previously possible with a microscope and can carry out more extensive surgery. As compared to the microscopic surgery the neuroendoscopy provides:

* Panoramic views
* Better observation
* Additional illumination
* Increased overview
* Can ‘look around corners’
* Extended viewing angles
* Provides a ‘second prospective’
* Excellent visual quality in deep narrow fields

**Neuroendoscope holder**

An endoscope holder is a device used to mount and fix the neuroendoscope in a particular position during the operation. It acts as a third arm of the neurosurgeon. Articulated arm allows movements in different directions and provides some degree of freedom even if the frame is fixed.

Neuroendoscopy can be done either free hand or by using a rigid holder. However, this precludes the use of both hands during the procedure. In addition, fatigue and any corresponding minor movement proximally in the hand could potentially translate into a large, dangerous tip movement.

Adapters for the retractor system can be used to produce a stable holder, but dedicate endoscopic holders are available for both rigid and flexible endoscopes. The most commonly used holders are the mechanical holders. They are designed to provide some freedom of movement even if after the frame is locked into place.

A particularly novel method uses a pneumatic system. It is used to maintain the rigidity once the desired configuration has been achieved. The device is connected to the same pressurized gas used to drive the power craniotomy drills. There are other techniques available such as motorized holders but they are very expensive.

**Importance of using the holder system**

Intracranial procedures are usually performed through a narrow corridor in the vicinity to important neurovascular structures. While endoscopic inspection can be done by freehand fixation of the device, endoscope-controlled micro-neurosurgical manipulations require its precise position, because monomanual surgical manipulations may be not only non-effective, but even dangerous if occasional shift of the endoscope occurs in the surgical wound.

This necessitates use of special holder, which can provide stable position of the device in the surgical wound and permits bimanual manipulations of the surgeon and assistant. These devices provide excellent maneuverability within 6 degrees of freedom, smooth manipulations with avoidance of strenuous maneuvers of the surgeon, accurate fixation in any direction, and safety release, which result in high level of clinical safety of the device. The following table summarizes the advantages and disadvantages of the free hand and holder assisted surgeries:

|  |  |  |
| --- | --- | --- |
|  | **Free Hand** | **Using Holder** |
| Advantages | * More freedom of movement particularly when configuration needs to be frequently changed, e.g. tumor removal | * Surgeon can use both hands * Minimizes accidental movements and tremor |
| Disadvantages | * More fatigue for surgeon * Risk of accidental movements | * More static * Inconvenient when frequent repositioning is needed |

**Mechanical Holder**

This is the most commonly used holder in endoscopic neurosurgery. It consists of rotation socket to clamp the holder to the operating table, articulated stand with five joints for different movements and a clamping jaw to hold the scope. The range of the clamping jaw is from 4.8 to 12.5mm.



Fig.1. Mechanical Holding Arm

There are several mechanics involved in the functioning of a mechanical holder, But, the ball and socket joint is the most important factor involved in functioning mechanical holding arm. A ball and socket joint (or spheroidal joint) is a joint in which the ball-shaped surface of one rounded structure fits into the cup-like depression of another structure. The distal bone is capable of motion around an indefinite number of axes, which have one common center. It enables the joint to move in many planes (almost all directions) within a limited range.

Thus ball joint is used for allowing free movement in two planes at the same time, including rotating in those planes. Combining two such joints with control arms enables motion in all three planes, allowing the front end of an automobile to be steered and a spring and shock (damper) suspension to make the ride comfortable.

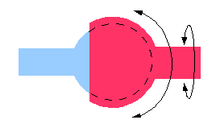


Fig.2. A Ball joints showing a limited range of smooth movement in all directions

Sealed ball joints do not require lubrication as they are "lubed for life". The holders consist of arms of different lengths which carry a ball or a wire clip (eye) on the ends. Several arms can be clipped together and the ball joint allows the holder to be moved into any configuration.   
All holder elements are made from stainless steel. The special design of ball joint ensures minimum size and permits perfectly smooth operation without any trace of spring-back.

**Pneumatic Holder**

A pneumatic system uses the pressure of a gas to perform work, specifically linear work. The word "pneumatic" comes from the Greek and refers to air, which is the least expensive and most common type of gas used in pneumatic cylinders. Air can be easily taken in and compressed to refill pneumatic systems, and does not pose the same danger as other gases. Fig. 3 shows the pneumatic holding arm:



Fig.3. Pneumatic Holding Arm

The pneumatic retraction and holding system for open as well as for minimally-invasive surgery is used inneurosurgery, orthopaedics and traumatology. The pneumatic holder can be directly connected to the OR compressed air supply. An integrated safety system prevents collapsing of holding arm in case of air supply failure. The main advantage of this type of holder is that it can be used controlled using single hand and provides precise and fine steering.

**Motorized Holder**

The motorized holding systems are electronically controlled. It is an ultra compact motorized endoscope holder for laparoscopic, coelioscopic and thoracoscopic surgeries. Its role is to hold and move the endoscope under the direct control of surgeon (voice or footswitch control).



Fig.4. Motorized Holding Arm

The motorized holding system entails the following components:

* Control unit with a software which analyses surgeon’s orders and activates motors,
* Passive arm fixed anywhere along the rail of the operating table,
* Camera driver positioned just above the patient’s abdomen and held in place by the passive arm,
* Control interface footswitches, wireless microphone.

**Brain Retractors**

Brain retraction is the method to hold brain tissues at a particular position for better exposure of the operative target or site. It is still one of the most important techniques to lessen brain damage. It can be achieved by handheld (by surgical assistant) or self retaining retractor systems. The former have disadvantages of slipping from the desired position, of causing excessive retraction, of obscuring the vision and light due to the assistant’s hand holding the retractor and of being unable to be maintained in one position for long time.

Self retaining brain retractors have been developed by various neurosurgeons to facilitate intracranial surgery at depth and maintain a delicate, stable constant retraction of brain without the need of handheld brain spatulas. The need for and hence evolution of self retaining retractors arouse because:

* Sustained, gentle retraction of neural tissue is required during many procedures,
* There should be minimal shearing or movement at brain – retractor interface,
* Ability to employ multiple retractors at the same time
* To reduce human error during prolonged surgery

The spectrum and diversity of these systems is large. However, self retaining retraction system consists of certain common features:

1. Brain Spatulas- These are flat, malleable blades of different shapes. The portion of the brain and amount of brain to be retracted would dictate the choice of a particular blade. Another characteristic of these blades is that they have non-reflective surface to minimize glare from reflective light used.
2. Flexible arms- These form the intermediate link between the retractor blade and the fixed rod/post. They consist of series of small metal pieces joined to each other by ball and socket joints.



Fig.5. Self retaining retraction system

1. The rod/post- It is attached to a rigid structure. It provides the stability and fix base to the retraction system.

During the past few decades many types of the brain retractors have been designed each having some advantages and disadvantages. The self retaining systems available can be broadly classified into four categories based on their mounting method:

1. **Skull mounted devices-**

These were earlier retractor systems. These were rods mounted in a drill hole in the skull with attached retractor. This simplicity was negated by the fact that each rod could hold only one retractor and multiple retractors meant multiple drill holes. Another type of skull mounted system is to fix the system to the edge of the craniotomy, This type of system can use the articulating ball and cable jointed arms to which the retractor can be attached. The original Leyla retractor system, (Aesculap, Germany) Introduced by M.G yasargil is one such device. The advantage is that the position and tension in the arm can be adjusted with the wire tensioner.

1. **Soft tissue mounted devices** –

These are secured by tension in the muscles and soft tissue but because of the relative mobility are inherently unstable. Examples are the systems designed by House and Urban mainly useful for the procedures around the auditory canal. Modifications were madew by Janetta, who used modified Weitlaner retractors. The popularity and use of these systems is restricted.

1. **Table mounted flexible arm systems** –

These systems are basically modification of the Leyla system. This system consists of angulated rod, which is fixed to the operating table. At the angled end of the rod a holder that can accommodate up to 6 arms at a time can be attached. The flexible arms (ball and cable jointed arms) can be attached to this holder. A variety of brain retractor blades then can be attached to the flexible arm. The advantages of this system are ease of setting up the system and flexibility afforded by the arms.

1. **Head rest mounted systems** –

In these systems, the base plate is attached to the skull clamp. The base plate may be semicircular or circular. At various points on the circle the retractor arms can be attached. This has the advantage that multiple retractors can be attached around the arc of the circle. These also have hand rests incorporated in the system. Disadvantages include requirement of a specific head clamp for specific systems, i.e. they are not interchangeable.

**Conclusion**

Since 1938, with the invention and introduction of self retaining retractors, a variety of instruments designed to retract the brain have been designed. Each has its advantages and disadvantages. Ideally, a brain retraction system should not compress brain at all, but protect it. The injurious effects of retraction system are directly related to the force and time duration of the applied retraction. The operating table mounted arm with the Leyla retractor system is still the preferred choice.

While using a brain retractor system a number of precautions should be taken. A rubber sheet or cotton strip is placed under the retractor to reduce the pressure exerted on the underlying tissue. Wherever possible the need of brain retractor should be minimized by proper head positioning, good anaesthesia, cisternal cerebrospinal fluid drainage and adequate bone drilling. Resection of tumor should take precedence over retraction of the brain. Intermittent mild retraction should be done and the retractor should be removed from the area where the surgery is not being done. The brain spatula should only be manipulated.