Concept, Design and Development of Innovative Endoscope Holder System for Endoscopic Otolaryngological Surgeries

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Abstract Endoscopic surgeries have gained popularity not only in ENT but also in other surgical faculties. Endoscopic approach for sinus surgeries and otologic surgeries is well known. However, the major disadvantage of endoscopic aided surgeries as against microscope aided surgeries is thought to be the effective reduction in the working hands as the non-dominant hand of the surgeon is utilized for holding the endoscope. This urged the need for development of the endoscopic holder so as to allow both the hands of the surgeon for surgical manipulation.

Keywords Endoscope · Endoscope holder · Endoscopic surgery

Description

Background of the Invention

Field of Invention

The present invention relates to a device for fastening an endoscope holding metallic plate instead of optical observation instrument, particularly in an operation microscope, on a supporting stand.

Description of Prior Art

Operation microscopes have illustrative use in microsurgery [1, 2]. In order that the operator can have both his hands free at all times for his surgical work, such microscopes are fastened to a supporting stand, and the stand must be so devised that the operation microscope can be brought into a specific position [1, 2].

The most frequently used type of stand is a portable floor stand, establishing a vertical column. In one known embodiment, such a stand is equipped with a vertically adjustable horizontal arm which is swingable by 360 column, the horizontal arm remains securely at any desired height. Foot-actuated bolts, with brake blocks in the base part of the stand, permit rapid and dependable locking, at a given floor position. The operation microscope itself is attached to the horizontal arm by an articulation member and couplings, so that it can be brought into any desired position. In such position, its optical axis can be swung through a large angular region by rotation about a mechanical axis in a vertical plane [1, 2].

In addition to floor stands, stands with wall or ceiling or directly to operation table attachment are also known. They can be used only in a fixed or stationary context but have the advantage that they take up little space. They are generally equipped with a swivel arm which makes it possible to bring the operation microscope into any desired position in space, within a certain range [1, 2].

In the Fisch and Yasargil stands which are used for ENT and neurosurgery, the operation microscope can be displayed in three degrees of freedom of translation and three degrees of freedom of rotation, with counterweight balancing in each case.

Endoscopes are widely used for observing the internal organs of humans and other large biological specimens.

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The use of this instrument permits investigation of organs without the need for invasive and traumatizing surgical procedures. Endoscopes are used for diagnostic, research, and surgical purposes.

In use, a doctor holds the endoscope while inserting one end into the specimen's body via an incision or opening in either the respiratory system or gastrointestinal tract. Once through the incision or opening, the end of the endoscope is maneuvered into a passageway leading to the specific area to be observed. Generally, the surgeon holds the endoscope in one hand while performing the desired surgical procedure with the other hand [3].

In present invention, the optical instrument or assembly which is used for microsurgery operation is completely removed and metallic plate which holds any endoscope is fastened or mounted or fixed with screw on railing system available for fine adjustment in operating microscope. Thus it retains all movements of optical system used for focusing on operating site during operation. (Application for Patent in respect of "Multi-Action Self Retaining Rotatory Endoscopic Holder" bearing Application No.2313/MUM/2013 in the name of Dr. Mubarak Khan to Patent controller of India.)

Brief Statement of the Invention

The object of the present invention is to create a device of simple construction, and therefore low cost, which makes it possible.

- (a) To easily hold any endoscope to a selected stand-supported working position in space, and within a relatively large solid angle.
- (b) To lock the endoscope in any such position.
- (c) To control the manual motion of endoscope in any direction or angle in space with bar of two handles (Like bicycle handle).

The invention achieves this object by using a piece of a metallic plate of $90 \times 40 \times 12$ mm in dimensions with a slot measuring 15×15 mm in diameter.

where is the hinge joint with two screws, is the green screw to fix endoscope,

is the red arrow shows the opening action of outer

segment to accommodate endoscope, is the two blue screws for fixation to the railing microscope stand, A is the 16 mm, diameter of the circular slot is to accommodate endoscope.

This holder can be affixed to railing system (which is available for fine focusing) of any operating ENT microscopic stand with two screws (blue screws in figure) after detaching the optical observation instrument of the microscope. The circular slot (a in figure) of 16 mm diameter in metallic plate half of which (b in figure) is on main attachment and half of which (c in figure) opens outside to accommodate any endoscope for fixation (action is represented by red solid arrow). This opening part (c) of metallic plate is attached to main part (b) with hinge joint (yellow screws in figure) with 90 degree of motion. This opening part (c) then can be fixed to main part (b) of metallic plate with adjustable screw (green screw in figure). In other variant instead of hinge joint this opening part (c) can be fixed with two identical long adjustable screws (green screw). The inner part of circular slot (a) is reinforced with soft silicone or malleable plastic thin material to hold neck of endoscope which holds it firmly and does not cause undue pressure on gentle optical fibers of any rigid endoscope. This slot (a) is at 80 mm distance from its attached end and can be made of any suitable diameter to accommodate different rigid endoscopes of different diameters.

In a further embodiment to control the manual motion of endoscope in any direction or angle in space with bar of two handles (Like bicycle handle), additional attachment of two light weight metallic bars can be fixed between railing system of microscopic stand and metallic plate for endoscopic holder. With this arms it is easy to move endoscope in any direction in space (rotated forwards, rotated backwards, upwards, downwards and sidewise angular rotation) at any level convenient to the operator. Thus all actions of operating microscopes are utilized for rigid endoscope which are very valuable.

The described apparatus is combined, in particularly advantageous embodiments, with known stands and in particular with portable stands, with stands for wall or ceiling attachment, and with stands which have a table base or a floor-clamping device. Combination with a vertically adjustable horizontal arm or with a swivel arm is particularly suitable.

Summary of the Invention

It is an object of the present invention to provide an holder for endoscope which does not suffer from the foregoing disadvantages and limitations.

It is a another object of the invention to provide an endoscopic holder which will fix the endoscope in any position and permits multidirectional viewing of the internal areas of biological specimens during surgical operations.

It is a further object of the invention to provide an endoscopic examination apparatus which permits a surgeon to use both hands while performing medical procedures.

It is yet another object of the invention to provide an apparatus for moving endoscope with handles (like bicycle handles) easily any direction for viewing of the internal areas of a biological specimen.

It is yet another object of the invention to provide an apparatus for moving endoscope into and fro motion (like fine focusing in operating microscope) by using railing system of microscope. This motion can be enhanced by increasing the length of railing system as per requirement in future.

Other general and specific objects of the invention will in part be obvious and will in part appear hereinafter.

The present invention is characterized by an modification of operating microscope that is fastened with metallic plate to hold any endoscope and used for endoscopic ear nose and throat diagnostics and surgery along with endoscopic camera.

The invention accordingly comprises the steps and apparatus embodying features of construction, combinations of elements and arrangements of parts.

Adapted to effect such steps, as exemplified in the following detailed disclosure. The scope of the invention is indicated in the claims.

Brief Description of the Drawings

A fuller understanding of the nature and objects of the present invention will become apparent upon consideration of the following detailed description taken in connection with the accompanying drawings (Figs. 1, 2, 3, 4, 5, 6, 7).

Detailed Description of the Preferred Embodiments

Referring to Figs. 1 through 7,

- a Main body of metallic endoscopic holder
- b Other part of metallic holder for fixation of rigid endoscope
- c Tightening screws
- d Circular hole in metallic plate to accommodate rigid endoscope
- d1 Hemispherical slot in main body (a)
- d2 Hemispherical slot in fixating part (b)

Fig. 1 Front view of a first embodiment of the invention having a solid any metallic plate containing a single hole of 16 mm diameter for holding any rigid endoscope

Fig. 2 Front view of the first embodiment of the invention depicted in Fig. 1 This view depict locking system for rigid endoscope

- e Screws for fastening the endoscopic holder to railing system (fine focusing) of operating microscope
- f Handle for maneuvering endoscope holder in all directions
- g Metallic hinge joint between main body (a) and fixating part (b)
- h Movable metallic plate on railing system of operating microscope to which endoscopic holder along with handle is fastened with screws (e)
- i Railing system of operating microscope used for fine focusing

Fig. 3 Front view of a second embodiment of the invention having a variation with one tightening screw and hinge joint

Fig. 4 Front view of a second embodiment of the invention having a variation with one tightening screw and hinge joint in open position

den Rigid endoscope in locked state in endoscopic holder

Claims

What is claimed is:

- (1) A freestanding operating apparatus for holding a rigid endoscope for ear nose and throat under observation and surgical procedures, said operating apparatus (Supplemental digital content, Fig. sdc1). Comprising:
An rigid endoscope is held firmly in metallic plate sized and shaped to hold neck of rigid endoscope for

Fig. 5 Lateral view of the second embodiment of the invention depicted in Fig. 3

Fig. 6 Lateral view of a third embodiment of the invention having a rigid endoscope in locked state in endoscopic holding attachment

surgical purposes said endoscope having an observation end and an insertion end, said endoscope including a first lens image transmission means for non-electronically transmitting an optical image from said insertion end of said endoscope to said observation end of said endoscope and an illuminating means for transmitting light to said insertion end; and an operating microscope operatively connected to said observation end of said endoscope with endoscope holding assembly instead of optical system, said operating microscope is modified by removing an optical viewing system and endoscopic holding assembly is fastened to railing system meant for fine focusing in said operating microscope (Supplemental digital content, Fig. sdc2).

Fig. 7 Lateral view of a third embodiment of the invention having a rigid endoscope in locked state along with railing system of operating microscope as depicted in Fig. 6

- (2) The apparatus of claim 1 further including a means for locking said endoscope in a selected position after positioning in said cavity or incision.
- (3) The apparatus of claim 1 including a rigid endoscope in holder means operatively connected to railing system for fine focusing in said operating microscope for the optical image transmitted by said first lens means of endoscope (supplemental digital content, Fig. sdc3).
- (4) The apparatus of claim 3 wherein said rigid endoscope holding assembly means further includes metallic handles (like bicycle handles) between endoscopic holder and railing system of said operating microscope for movement of endoscope in any directions with both hands (supplemental digital content, Fig. sdc4).
- (5) The apparatus of claim 1 further including an endoscope rotating means, said rotating means providing a means for rotating said endoscope about its longitudinal axis.
- (6) The apparatus of claim 1 further can be modified for holding rigid endoscope by different variation like by two fixating screws OR by one fixating screw and hinge joint OR by locking assembly on opposite side of hinge joint (like suitcase locks).
- (7) The apparatus of claim 6 with endoscope in locked position now can be attached to endoscopic camera for transmitting images to monitor and fiberoptic

light is attached to endoscope for illumination during operation (supplemental digital content, Fig. sdc5).

- (8) The apparatus of claim 7 can be positioned in any direction by using all actions of operating microscopes (movements in vertical, horizontal and longitudinal axis of endoscope) (see video supplemental digital content, endostand video.3gp).
- (9) The apparatus of claim 8 gain motion of rigid endoscope in fixed state with predetermined distance on railing system (fine focusing) of operating microscope (supplemental digital content, Fig. sdc7).
- (10) The apparatus of claim 8 can be applied to operating microscopes of any model (Floor, wall or table model).
- (11) The apparatus of claim 8 can be used to hold any rigid endoscope used in different medical faculties for diagnostic and therapeutic purposes (supplemental digital content, Fig. sdc6).
- (12) The apparatus of claim 8 can be used in ENT diagnostic and therapeutic purposes (for diagnosis and surgical purposes).

Disadvantages Found in Previous Art Search

- (1) Wingman's scope holder is pneumatic driven scope holder and holds 5 or 10 mm endoscope which can be mounted on operating table. It holds endoscope in fixed position during operation and has disadvantage of range of motion and fine movement. It needs to move with operator's other hand mechanically during repositioning in biological cavity during surgery. Hence variable force of different operator's hands make it unsafe during otological(Ear) or nose surgery. This scope holder is mostly used for laparoscopic surgery. But our holder overcomes these difficulties as mentioned below.
- (2) "Morita and Okada et al. [4], Development of hybrid integrated endoscope holding system for endoscopic microneurosurgery, Neurosurgery, 2004, octo;55(4):926-31" This reference mainly related to endoscope holder needed neurosurgery. Our endo holder has multipurpose uses as mentined below.
- (3) Integra™ Jarit® Endoscope & Instrument Holder consists of
 - Articulated arm
 - Scope holder—4/10 mm
 - Column—length 30 cm
 - Rail clamping base, double clamp (620-804) and it has following disadvantages

- (a) If the rail clamping base is not tightened correctly, it may become loose which may cause injuries.
- (b) The fixation of the articulated arm is based on the principle of friction. Changing the position without loosening the clamping mechanism can cause damage and will shorten the lifespan of the Jarit® Endoscope & Instrument Holder.

(4) Endoscope-holding device.

EP 2446807 A1

Synopsis A distal arm that holds a rigid endoscope and includes a multi-joint articulated arm including first to fourth distal arm portions sequentially connected from a base portion side, and these first to fourth distal arm portions are configured so as to move on a vertical plane with horizontal rotational shafts as supports. In addition, behaviors of the respective distal arm portions are linked by a linking mechanism so that the first distal arm portion and the third distal arm portion behave in parallel to each other, and the second distal arm portion and the fourth distal arm portion behave in parallel to each other.

This endoscopic holding device made of multiple ball and socket joints and arms and if these are fixed properly there is danger of rigid endoscope along with camera system (additional weight on endoscope) moving in uncontrolled manner in biological cavities during surgeries. In long run multi joints are vulnerable to addition wear and tear leading to uncontrolled and undesired movements which is dangerous during surgery and focusing of biological cavities.

Advantages of Our Endoscope Holder Over Previous Art Search

- (1) Our endoscope holder is innovatively modified from operating microscope used for Ear, Nose and Throat surgeries and retains all advantages of operating microscope and it is completely different from previous holders.
- (2) Thus This holder will be used for ear nose throat surgery and could be used for other specialties too. All above art search lacks in many important features (as mentioned above) which are must during ear nose throat endoscopic surgeries.
- (a) During Ear surgery with endoscope, it is very critical to work in ear canal of 24 mm length precisely. The previous art search suggests manual movement of endoscope along this canal or any other cavity with operator's hand which may be jerky or uncontrolled. But our endoscope holder is mounted on railing

system of Fine focusing of operating microscope, thus making endoscope movement fine and precise once it is kept in any cavities. Considering the previous art, any jerky movement of operating surgeon's hand is avoided in our holder.

- (b) If automatic motorized fine control is used in operating microscope's fine focusing, then this endoscope movement can be controlled with foot pad button very precisely.
- (c) As this is sturdy microscope stand (floor model), it bears the all different weights of additional camera and fiberoptic cables. Which gets uncontrolled and undesirable in long run in previous art search.
- (d) Additionally the cold light source can be incorporated in body of Floor model of operating microscope stand, making it very convenient for endoscopic surgery as one unit along with monitor on top. This is unavailable in previous art.
- (e) Even handy table model of microscope stand can be modified as endoscope holder. It is very cheap and simple way for holding endoscope during surgeries.
- (f) The fine focusing of microscope system (railing mechanism) can be increased to any desired distance. Thus making it to move endoscope in fixed position in any biological cavity in controlled and desired way smoothly.
- (g) As Operating microscope stand is counterbalanced for the weight of optical system, hence even endoscope holder along with any camera head and fiber optic cable is balanced smoothly avoiding the jerky movements during critical operation in small cavities like ear nose and throat.
- (3) Our endoscope holder is very unique at present for ear nose and throat surgery which are done by using rigid endoscope. This holder will be useful for diagnostic as well as therapeutic purposes in otorhinolaryngology. (We have recorded many ENT surgeries with this innovative endoscope holder, Table 1). This both activities are not at all possible in any previous searched art.
- (4) The same endoscope holder can be used in different areas of medical specialties where rigid endoscope is part of endoscopic surgeries (Needs evaluation by other faculties). Previous art shows specialized endoscope holder for different medical specialties.
- (5) When our endoscope holder is used as whole unit (like floor model of operating microscope), it is very convenient to orient the rigid endoscope in any direction in space during operative handling which is not possible in previous art.
- (6) The advantage of our endoscope holder is that it is mounted on fine focusing rail system of operating microscope thus allowing the smooth and precise

Table 1 Otolaryngological procedures done with our endoscopic holder system

Otolaryngological procedures	Numbers
1. Type 1 sliced cartilage tympanoplasty	14
2. Stapes surgery	5
3. Ossiculoplasty	2
4. Myringotomy	6
5. Grommet insertion	4
6. Septoplasty	6
7. Septoplasty with cut & suture technique	2
8. Rhinoplasty	3
9. Laryngeal office based biopsy	6
10. Oropharyngeal foreign body removal	5
11. Endonasal DCR	8
12. FESS	3
13. Tonsillectomy	4
14. Video recording of oral cavity and head & neck procedures (Ranula, branchial cyst, thyroid)	6

movement of rigid endoscope for desired distance in biological cavities(ear nose throat).Which is absolutely not possible in any holder in previous art search.

Patent Citations

Cited Patent

- (1) Endoscope holder and endoscope device
US 6569084 B1
- (2) Endoscope-holding device
EP 2446807 A1

- (3) Microscope
US3401999
- (4) Endoscopic operating microscope
US 5295477 A
- (5) Operating microscope
US 5805335 A
- (6) Stand apparatus for medical optical instrument
US5205522
- (7) Low profile scope holder
US 5957423 A
- (8) Suspension apparatus for operating room microscope
US4170336
- (9) Dual-axis endoscope holder
US5571072
- (10) Stryker scope holder

Conflict of interest Application for Patent in respect of “Multi-action Self Retaining Rotatory Endoscopic Holder” bearing Application No. 2313/MUM/2013 in the name of Dr. Mubarak Khan to Patent controller of India.

References

1. US Patent: Operating microscope, US6088154
2. US Patent: Operating microscope, US6266182
3. Microscope/endoscope assembly, EP1006390A1
4. Morito A, Okada Y et al (2004) Development of hybrid integrated endoscope holder system for endoscopic microneurosurgery. *Neurosurgery* 55(4):926–931