LAPAROSCOPY INSTRUMENTS AND METHOD FOR SUTURING AND LIGATION

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ABSTRACT

An improved combined laparoscopic needle and forceps comprising an elongated parallelogram type of linkage suitable for insertion through a trocar and having first and second ends, a needle, means for mounting said needle on said first end for movement from a position in substantial alignment with said linkage, which permits it to pass through a trocar, to a position transverse to said linkage, handle means on said second end of said linkage for actuating said linkage to effect movement of said needle, and a forceps construction including jaw means mounted proximate said first end of said needle linkage and being formed from a portion of said linkage and a portion of the holder of the needle. An improved combined laparoscopic forceps, suture guide and cutter comprising an elongated parallelogram type of linkage which is sufficiently slender for passage through a trocar and having first and second ends, jaw means on said first end, and handle means on said second end for actuating said linkage to move said jaws, groove means associated with said jaws for receiving a suture to thus act as a suture guide, and cutter means mounted on said jaws for cutting a suture. An improved laparoscopic ligator comprising an elongated stem having first and second ends, a handle at said first end and suture guiding means at said second end, said suture guiding means being of substantially the same cross sectional dimension as said elongated stem for guiding a suture through a trocar. An improved method of performing a surgical operation by laparoscopy comprising the steps of inserting at least first and second trocars through the body of a patient at spaced locations, inserting a first instrument comprising the above described combined laparoscopic needle and forceps through said first trocar, inserting a second instrument comprising the above described laparoscopic forceps, suture guide and cutter through said second trocar, manipulating said first and second instruments in cooperation relationship with each other in a predetermined area to the central portion of a suture in position, withdrawing one of said instruments to bring the end of the suture outside of the patient's body, tying a knot in the suture outside of the body, and bringing the knot into the desired position by means of said laparoscopic ligator.

1 Claim, 25 Drawing Figures
LAPAROSCOPY INSTRUMENTS AND METHOD FOR SUTURING AND LIGATION

This is a division of application Ser. No. 175,163, filed Aug. 26, 1971, and now U.S. Pat. No. 3,763,860. The present invention relates to improved laparoscopy instruments for suturing and ligation and to an improved method of laparoscopy.

By way of background, recently there has been an increasing use of laparoscopy in pelvic surgery. The most common uses of laparoscopy are for diagnosis of pelvic disease and tubal electrocoagulation and cutting. Among the operations performed with a great degree of safety and less morbidity for the patient than by laparotomy are: biopsy and electrocoagulation; lysis of adhesions with electrocoagulation; fertility studies by in-tratureine dye injection; ovarian follicle aspiration; biopsy of the ovary; extended post coital aspiration tests; tuboplasty by opening the fimbricated ends of closed tubes; cul-de-sac aspiration; ovarian cyst aspiration; electrocoagulation of bleeding points such as bleeding corpus luteum or bleeding secondary to instrumentation; electrocoagulation of endometriosis; electrocoagulation of tumor implants; biopsies in general; and excision of small tumors with electrocoagulation.

In certain of the foregoing procedures difficulty has been encountered when blood vessels are cut and hemostasis cannot be maintained by electrocoagulation. This bleeding has been an especially troublesome problem in tubal electrocoagulation and cutting. When bleeding difficulties have been encountered, laparotomy has become necessary because of the past inability to suture and ligate with laparoscopic procedures.

It is accordingly one important object of the present invention to provide an improved series of instruments which increase the ability to suture and ligate in laparoscopy. A related object of the present invention is to provide a combined laparoscopic needle and forceps. Another related object of the present invention is to provide a combined laparoscopic tissue forceps, suture guide and cutter. A further related object of the present invention is to provide an improved laparoscopic ligator.

Another object of the present invention is to provide a new and improved surgical method of laparoscopy. Other objects and attendant advantages of the present invention will readily be perceived hereafter.

The improved combined laparoscopic needle and forceps of the present invention comprises an elongated linkage portion having first and second ends, a needle, means for mounting said needle on said first end for movement from a position in substantial alignment with said linkage, which permits it to pass through a trocar, to a position transverse to said linkage, means on said second end of said linkage for actuating said linkage to effect said movement of said needle, and a forceps construction including jaw means mounted proximate said first end of said linkage.

The improved combined laparoscopic forceps, suture guide and cutter comprises an elongated linkage having first and second ends, jaw means mounted on said first end and handle means on said second end for actuating said linkage to move said jaws, groove means associated with said jaws for receiving a suture to thus act as a suture guide, and cutter means mounted on said jaws for cutting a suture.

The improved laparoscopic ligator of the present invention comprises an elongated stem having first and second ends, a handle at said first end, and suture guiding means at said second end, said suture guiding means being of substantially the same cross sectional dimension as said elongated stem for guiding a suture through a trocar.

The improved method of performing a surgical operation by laparoscopy, in its broadest aspect, comprises the steps of inserting at least first and second trocars through the body at spaced locations, inserting a first instrument through said first trocar, inserting a second instrument through said second trocar and manipulating said first and second instruments in cooperating relationship with each other in a predetermined area to perform said operation.

The various aspects of the present invention will be more fully understood when the following portions of the specification are read in conjunction with the accompanying drawings wherein:

FIG. 1 is a side elevational view of a trocar of the type suitable for use in a laparoscopy;
FIG. 2 is a fragmentary cross sectional view thereof taken substantially along line 2--2 of FIG. 1;
FIG. 3 is a side elevational view of a combined laparoscopic tissue forceps, suture guide, and suture cutter;
FIG. 4 is an enlarged fragmentary top plan view thereof taken substantially in the direction of arrows 4--4 of FIG. 3;
FIG. 5 is a fragmentary longitudinal sectional view thereof taken substantially along line 5--5 of FIG. 4 and showing the suture guide and cutter associated with the jaws;
FIG. 6 is an enlarged fragmentary longitudinal sectional view of the rear portion thereof taken substantially along line 6--6 of FIG. 9 and showing the linkage associated with the handles;
FIG. 7 is a cross sectional view thereof taken substantially along line 7--7 of FIG. 5 and showing the suture cutter structure;
FIG. 8 is a cross sectional view thereof taken substantially along line 8--8 of FIG. 5 and showing the jaw mounting linkage;
FIG. 8A is an enlarged cross sectional view thereof taken substantially along line 8A--8A of FIG. 3 and showing details of the spring structure for biasing the links together;
FIG. 9 is a fragmentary cross sectional view thereof taken substantially along line 9--9 of FIG. 6 and showing the linkage associated with the handles;
FIG. 10 is a side elevational view of a combined laparoscopic needle and forceps;
FIG. 11 is an enlarged fragmentary top plan view thereof taken substantially in the direction of arrows 11--11 of FIG. 10;
FIG. 12 is a fragmentary longitudinal sectional view thereof taken substantially along line 12--12 of FIG. 11 and showing the linkage for moving the needle and the jaws;
FIG. 13 is a fragmentary view similar to FIG. 12 but showing the forceps jaws open;
FIG. 14 is a cross sectional view thereof taken substantially along line 14--14 of FIG. 12;
FIG. 15 is an enlarged fragmentary longitudinal sectional view thereof taken substantially along line
15—15 of FIG. 16 and showing the linkage associated with the handles;

FIG. 16 is a fragmentary cross sectional view thereof taken substantially along line 16—16 of FIG. 15;

FIG. 17 is a side elevational view of a laparoscopic ligator with an open ended circular tip;

FIG. 18 is a fragmentary enlarged view of the ligator of FIG. 17 with the handle portion of the ligator illustrated in section;

FIG. 19 is a fragmentary cross sectional view thereof taken substantially along line 19—19 of FIG. 18 and showing the tip of the ligator in greater detail;

FIG. 20 is a fragmentary perspective view showing the first step of a surgical operation wherein a tissue tube is clamped by the forceps and the needle is brought into the clamped area;

FIG. 21 is a view showing the needle deflected around the tube with the forceps released from the tube and grasping the end of the suture;

FIG. 22 is a fragmentary perspective view showing the suture being held in the suture guide portion of the forceps with the forceps associated with the needle pulling the suture;

FIG. 23 is a fragmentary perspective view showing the ligator pushing the suture knot toward the tube; and

FIG. 24 is a fragmentary perspective view showing the cutter portion of the forceps severing the suture after tying has been completed.

By way of introduction, the laparoscopy which is performed with the instruments of the present invention consists of the steps of inserting first and second sheathed trocars approximately 4 centimeters above the lower third of the inguinal ligament on each side of the patient. A third trocar is inserted through the navel for receiving an endoscope. A tissue forceps is inserted through the first trocar to hold the tissue which is to be sutured-ligated. Through the second trocar, the laparoscopic needle threaded with suture is introduced and brought into the area of the tissue forceps. Thereafter the instruments are manipulated as will be described hereafter after their structure has been described.

The trocars which are used are shown in FIGS. 1 and 2. In assembled condition the trocar includes a stem associated with a pointed end at one end and a head at the other end. A sheath is located on stem and mounts an enlarged portion which includes a diaphragm member mounted thereon. As is well understood by those skilled in the art, the assembled stem and sheath are inserted through the skin and thereafter stem is withdrawn leaving sheath in place. The laparoscopic instruments are inserted through tube and a seal is maintained with them by means of diaphragm 16, to prevent the escape of gas which has been pumped into the abdominal cavity to separate the abdominal wall from body organs. This sealing is effected in the manner shown in FIG. 2 by having the circular diaphragm 16 engage the instrument.

The combined laparoscopic tissue forceps, suture guide and cutter 17 is shown in FIGS. 3—9. Basically, it includes a pair of elongated slender links 18 and 19 which lie in side-by-side relationship and are attached at one end to each other by means of cross link 20 which is pivotally mounted on pin 21 secured to the bifurcated end 22 of link 18, and is also pivotally mounted on pin 23 on bifurcated end 24 of link 19. The opposite ends of links 18 and 19 are secured to each other by cross link 25 which has the end thereof pivotally mounted on pin 26 attached to opposite side portions 26' of link 19 and an adjacent portion pivotally mounted on pin 27 mounted on bifurcated end 18' of line 18, as can be seen from FIGS. 6 and 9. Link 25 is essentially an extension of handle 28 having finger receiving opening 29 therein. Located proximate handle 28 is handle 30 which is an extension of link 18 and has finger receiving opening 31 therein.

Links 18, 19, 20 and 25 essentially define a parallelogram of type of linkage so that when handle portions 28 and 30 are spread apart from the position shown in FIG. 3 link 19 will move essentially in the direction of arrow 32 relative to link 18 which moves essentially in the direction of arrow 33 relative to link 19. The foregoing action will cause link 20 to pivot in a clockwise direction as viewed in FIG. 5 about pin 21 which in turn will cause jaw 34 which is formed integrally with link 20 to pivot in a clockwise direction about pin 21 to thereby move away from jaw 35 which is an extension of link 18 and formed integrally therewith. It will be appreciated that jaws 34 and 35, when closed, can be inserted through trocar sheath 14 and links 18 and 19, in all positions thereof, can be moved relative to sheath 14, as is required during surgery. A spring structure 19' (FIGS. 3 and 8A) biases links 18 and 19 together to maintain jaws 34 and 35 biased to a closed position. Spring 19' includes a longitudinally extending strip 20' from which U-shaped portions 21', 22' and 23' extend, with portions 21' and 23' embracing link 19 and portion 22' embracing link 18. A plastic sheath, not shown, can be used to cover spring 19' so that it will not snag in the trocar.

The combined laparoscopic tissue forceps, suture guide and cutter 17 performs a plurality of functions. First of all, jaws 34 and 35 have serrations 34' and 35' on their opposing surfaces to provide a good grip on either the tissue or the suture which is to be held. In addition jaws 34 and 35 have opposite opposing surfaces intermediate the ends of the serrated portions 34' and 35'. When the jaws are closed grooves 36 and 37 provide an opening or hole 38 having a continuous periphery. As will become more apparent hereafter, a suture can be received in opening 38 and guided therethrough during a suturing operation. In addition, jaws 34 and 35 have shear blades 39 and 40, respectively, secured thereon to provide a suture cutting action as well as become more apparent hereafter. Because of the fact that the combined laparoscopic forceps, suture guide and cutter performs a plurality of functions, it is not necessary to insert a plurality of individual instruments through a particular trocar sheath because the same instruments can be maintained in position therein to perform a plurality of functions, as desired, thereby lessening the number of times that entry need be made through the trocar.

The combined laparoscopic needle and forceps 41 of the present invention, shown in FIGS. 10—16, includes a pair of elongated slender links 42 and 43 which are maintained in side-by-side relationship by cross links which provide a parallelogram type of linkage. More specifically, cross link 44 is pivotally connected to link 42 by pin 45, to link 43 by pin 46. Pin 45 is secured to the bifurcated end portion of link 42, and pin 46 is secured to opposite sides 47' of link 43. The lower end of link 44 lies within depression 47 in link 43. Needle holder portion 48, which supports needle 49 at its outer
end, is formed integrally as an extension of link 44. The ends of links 42 and 43 which are remote from needle 49 are fastened together by link 50 which is pivotally mounted on pin 51 carried by opposite side portions 51' of link 42 and on pin 52 mounted on bifurcated end 52' of link 43. Link 50 is an extension of and integral with handle 53 having finger-receiving opening 54 at the end thereof. Handle 55 having finger-receiving opening 56 at the end thereof is integral with an extension of link 43.

By suitable manipulation of handles 53 and 55 link 42 can be caused to move in the direction of arrow 57 (FIG. 13) relative to link 43 which moves in the direction of arrow 58 relative to link 42. This will cause link 44 and needle holder 48 to pivot from the position shown in FIG. 12 to the position shown in FIG. 13. A detent tab 59 is rigidly attached at portion 60 to handle 53, and handle 55 slides across tab 59 in frictional engagement therewith. Thus when handles 53 and 55 are released, the needle holder 48 will remain in the position in which it was last placed until the handles are again manipulated. Because needle 49 can move from a position shown in FIG. 12 to the position shown in FIG. 13, it can be moved essentially through a right angle after it is placed in position within the body, as will become more apparent hereafter. It will be appreciated that because of the slender nature of links 42 and 43, and further because needle 49 is in substantially longitudinal alignment therewith, the needle can be inserted through the trocar and thereafter be moved to any desired position therein, as required.

It is also to be noted that a pair of opposing jaws 61 and 62 are provided. Jaw 61 is located on one side of needle holder 48 and jaw 62 is located at the end of link 43 (FIG. 13). It can thus be seen that the combined laparoscopic needle and forceps can be used to provide both a sewing action and a clamping action as required to obviate the necessity of using two separate instruments, thereby lessening the number of times that entry and withdrawal of instruments need be made through the trocar.

The laparoscopic ligator 63 of the present invention, shown in FIGS. 17-19, includes an elongated stem 64 having an enlarged end 65 which is embedded in handle 66. The opposite end of ligator 63 is formed into a pair of curved integral arms 67 separated by slot 68. The end of stem 64 between the arms is formed or recessed into complimentary grooved portions 69. The suture is received in opening 70 for ligating, as will be described in greater detail hereafter.

The laparoscopy is performed by the above described instruments in the following manner. Firstly, as noted above, two sheathed trocars 14 are inserted approximately 4 centimeters above the lower third of the inguinal ligaments on each side of the patient, in the event the operation is for the purpose of tying off the Fallopian tubes. A third trocar is inserted through the navel for the purpose of receiving an endoscope. Through one lateral trocar sheath, the tissue forceps 17 is inserted and the tissue to be suture ligated, namely, the tube 71, is clamped and held between jaws 34 and 35. Through the other lateral trocar sheath the laparoscopic needle 41 is introduced. This needle prior to insertion is threaded with suture 72 which is held on needle 49 by being wedged into a crotch formed between the needle proper and protuberance 73 thereon. After the needle is brought to the proper position, such as shown in FIG. 21, and while the tube is still clamped as shown in FIG. 20, handles 53 and 55 are manipulated to move needle 49 from its in-line position to a lateral position where it extends transversely to links 42 and 43, this lateral position being illustrated in FIG. 21. After the needle has been so flexed, the tissue 74 is pierced to bring the suture 72 through the tissue. Thereafter handles 28 and 30 of the tissue forceps are manipulated so as to cause jaws 34 and 35 to release tube 71 and to grasp the end 75 of suture 72, as shown in FIG. 21, and disengage it from needle 49 which is then withdrawn from tissue 74. Next, the suture 72 is carried around tube 71 by forceps 17 and end 75 of suture 72 is clamped between the jaws 61 and 62 of laparoscopic forceps 41. The opening 38 formed between the jaws of forceps 17 may be closed around suture 72, as shown in FIG. 22, to provide a guide for suture 72 to prevent suture pull-out on disengagement from needle 49 being withdrawn through trocar 14 to bring the free end 75 of suture 72 outside of the body. The diaphragm 16 at the end of trocar 14 prevents the escape of gas from the inflated abdominal cavity and externally of this diaphragm free end 75 of the suture is tied with end 76 thereof to provide a first tie. This tie is then introduced by ligator 63 through sheath 14 (FIG. 23), with the tie being held in groove 70 of the ligator. This tie is carried down to the central portion 77 of the suture to close off tube 71. Thereafter second and third ties may be formed at ends 75 and 76 and brought down into position with ligator 63 in the same manner as just described. A surgical knot has been found to be most convenient to provide the type of tie at 78 which is desired. Thereafter the shear blades 39 and 40 which are located on forceps 17 are used to cut the free ends of suture 72 to complete the tying operation.

It will be appreciated that because each of the instruments 17 and 41 performs a plurality of functions, there is no necessity to keep reinserting different instruments through the trocars to effect the various functions which are required. Furthermore, because the links which form the main central body portions of the instruments are extremely slender and do not spread apart appreciably when the instruments are manipulated, they can be conveniently inserted and removed through the trocars and manipulated while therein as required.

What is claimed is:

1. A ligator comprising an elongated stem and suture guiding means at one end of said stem, said suture guiding means being of substantially the same cross sectional dimension as said stem and comprising a pair of spaced arms convexly outwardly curved about an axis extending transversely of said stem and converging toward each other at their tip ends remote from said stem and jointly with the end of said stem defining a generally circular opening for guiding a suture, said tip ends of said arms being spaced from each other to provide a suture entrance to said opening, and means for gently and firmly holding said suture comprising a blunt end on said stem opposite from said entrance, said end being convexly rounded to provide complimentary grooved recessed portions at the bases of said arms on opposite sides of said stem between said arms.

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