The LAPMAN® (Medsys, Gembloux, BELGIUM) is a dynamic laparoscope holder guided by a joystick clipped onto the laparoscopic instruments under the index finger of the operator. It confers optimal control of the visual field while operating, ensures stable and smooth displacement of the laparoscope, and allows the operator to work in conditions of restricted surgical assistance, due to either unavailability of staff or economic constraints. It has been tested successfully in pilot studies in laparoscopic gynecologic surgery.
INTRODUCTION

Currently, almost all gynecologic procedures performed by open surgery can be carried out by a laparoscopic approach. This transposition of classic open procedures to their laparoscopic equivalents is the result of development of both human skills and better-adapted instrumentation, and surgical environments during the last decades. However, while surgeons were busy investigating the feasibility of operations and working on their standardization, the quest for improved surgical comfort was effectively abandoned. Currently, with the feasibility phase considered to be largely complete, and with surgeon morbidity being described directly related to the discomfort of minimal access surgery, it is probably time to think about how the conditions and comfort of laparoscopic surgery can be enhanced.

Technological efforts are now focusing on all aspects: instrument design, instrument multi-functionality, full integration of the operating room, etc. The LAPMAN® laparoscope manipulator aims to improve the surgeon’s control with respect to displacement and positioning of the endoscope, and provide him with an intuitive means of directing the camera himself.

This manuscript reviews the rational for using a laparoscope-holding system, explains the indications, and investigates its applicability in laparoscopic gynecologic surgery.

RATIONALE FOR LAPAROSCOPE-HOLDING DEVICE

Two main arguments support the use of laparoscope-holding devices: ergonomics and economics.

Ergonomics

Ergonomically, the laparoscopic approach exposes the surgeon to encounter premature fatigue much more than open surgery conditions. Fatigue, in this context, should be understood in its complete sense: subjecting (characterized by a decline in mental alertness, mental concentration, motivation, and other psychologic variables); objective (a measurable decline in the quality and amount of work accomplished) and physiologic (demonstrated by disturbances in the ongoing physiologic processes).

Furthermore, besides the usual causes that contribute to fatigue and stress, such as standing for hours in awkward body and joint positions, factors that relate to management of the visual operative field by a human camera holder should also be taken into consideration. A tremor on the part of the assistant holding the laparoscope; for example, and the subjective impression of lack of translational and rotational stability of the image while displacing the endoscope are significant sources of mental stress, which fatigue the operator.

In addition, loss of laparoscope auto-control, the endoscope never being exactly where it should be and when it should be, adds to the surgeon’s mental frustration. In fact, this problem is new and specific to laparoscopic surgery: the symbiotic working relationship that links the operator’s hands and eyes during open surgery is affected. Vision is controlled by another person whose quality, interest, skill, and even availability, may be variable.

Economics

The economics also must be taken into consideration. Many European hospitals currently have a serious lack of human assistance for several reasons: limited numbers of residents in training, reduction in nursing staff, cost of human assistance, etc. Laparoscopic surgery, as a high consumer of personnel and laparoscope holders is different: their classifica
tion was based on the mode of activation: passive or dynamic. Passive holders are static systems manipulated physically by the operator himself; the laparoscope is first placed in an optimal position and the surgeon subsequently manipulates his instruments, as necessary. Any change in the position of the endoscope requires the surgeon to put down one instrument, reposition the system, then pick up his instrument again.

Dynamic holders are motorized devices and positioning of the endoscope can be achieved through remote control interfaces: voice, foot pedal, helmet, hand control, joystick, etc. This technology allows the surgeon to orientate the laparoscope while he operates with no interruption of surgery, and no need to drop one instrument to reposition oneself. The AESOP® series (1000 to 3000) (Computer Motion, Santa Barbara, CA, USA) was the first robotic manipulator of laparoscopes, activated initially by a foot pedal and later by voice control.1-9

The ENDOASSIST® (Armstrong Healthcare, High Wycombe, UK) is a console positioned alongside the patient, controlled by an association of foot and head activation through infrared technology.10 Both systems have been compared in experimental conditions.11,12

Manipulation of instruments is what makes the difference between laparoscope holders and fully operational robots, such as the DaVinci® (Intuitive Surgical, Sunnyvale, CA, USA). Thanks to 7-DOF laparoscopic instruments, these robots allow the surgeon to perform meticulous dissections and microsutures in restricted and difficult-to-reach areas. However, their exorbitant price, their volume, their technological complexity, and long set-up time, mean they have not yet entirely won-over the surgical community and their cost-effectiveness still needs to be evaluated.11 It should be made perfectly clear that the rationale for fully operational robots and laparoscope holders is different: robots are not meant to address economic concerns or lack of assistance in the Operating Room (OR); therefore, they are probably not for every general hospital.
The Manipulator (Fig. 1)
The technology behind this manipulator is based on the electromechanical control of brakes that regulate the displacement of a series of articulated arms constructed to cover the three-dimensions (3Ds) of space (Fig. 2). It is composed of a rolling unit that contains the engines, fitted with a sterile autoclavable shaft; the endoscope is connected to the shaft at the start of the operation. The overall dimension of the manipulator is 37 cm x 63 cm at the base, with a height of 110 cm that extends to 150 cm, depending on the needs.

The machine displaces the shaft in the 3Ds that translates the displacement of the laparoscope connected to it. These displacements naturally converge upon the geometric center of the manipulator. To have optimal translation of movements to the laparoscope, this geometric center must be aligned with the geometric center of the patient—the umbilicus—through a laser pointer.

The Interfaces
Two interfaces are available to control the manipulator: one for OR staff (remote control) and one for the surgeon (LAPSTICK®, Medsys, Gembloux, Belgium).

1. The Remote Control
   This is the nurses’ unit used by OR staff during the phase of alignment of the LAPMAN® with the patient’s umbilicus.

2. The Joystick (LAPSTICK®)
The ergonomics of PC joysticks inspired the development of an interface adaptable to laparoscopic surgical instruments. This cord-free device (LAPSTICK®) (Fig. 3) is the size of a matchbox and is positioned on the handle of the instrument, on the right or left side, at the level of the index finger; the position is adjustable to the anatomy of the hand. It boasts two 4-DOF joysticks that command both in/out penetration and right/left lateralization; the up/down movement is managed by a flap, whose design makes it distinguishable to the index finger. It can be adapted through a clip to regular handles from major instrument companies, and has an autonomy of five hours of continuous radiofrequency activation.

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**Table I**

<table>
<thead>
<tr>
<th>Gynecologic Laparoscopic Procedures Performed with the LAPMAN®</th>
<th>14</th>
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<tbody>
<tr>
<td>Adnexectomy</td>
<td>18 (*)</td>
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<tr>
<td>Ovarian cystectomy</td>
<td>7</td>
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<tr>
<td>Salpingostomy (ectopic preg)</td>
<td>2</td>
</tr>
<tr>
<td>Salpingectomy</td>
<td>5</td>
</tr>
<tr>
<td>Myomectomy (subserosal)</td>
<td>4</td>
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<tr>
<td>LASH</td>
<td>4</td>
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<tr>
<td>Diagnostic laparoscopy</td>
<td>8</td>
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</table>

(*) = One case with severe adhesions that requires one assistant in a patient with a history of pelvic surgery.
LASH = Laparoscopic Subtotal Hysterectomy
The LAPSTICK® has replaced a previous interface (hand control), inserted under the surgeon’s glove, because of its greater intuitiveness.14

**USE IN GYNECOLOGY**

Set-Up (Fig 4)

In normal conditions for laparoscopic gynecologic surgery, three suprapubic contra-incisions are generally required: the total number of hands needed is five, to occupy the umbilical port and the three suprapubic ports, as well as for the uterine manipulation (Fig. 5). The operating surgeon uses his two hands to manage two instruments, the assistant two hands to hold the laparoscope and one instrument, and a nurse often lends a hand to manipulate the uterus while instrumenting. This means that three persons are scrubbed up to operate in optimal conditions: the surgeon, assistant, and nurse.

The LAPMAN®, by providing an extra hand, reduces the total number of hands needed to four: the surgeon’s two hands and the nurse’s two hands. The assistant is superfluous in this scheme of things and can be used for other tasks while the nurse’s competencies can be more fully used for installation of the patient, instrument preparation and distribution, holding of instruments if required, manipulation of the uterus, preparation of sutures, and so on.

As three hands are the absolute minimum for laparoscopic surgery (two to manage the instruments and one to hold the laparoscope), the LAPMAN® also allows the surgeon to operate in case of total absence of assistance (strict solo-surgery), a situation that occurs not infrequently during night calls in hospitals, where the availability of assistance is limited (ectopic pregnancy, acute abdomen of gynecologic origin, etc.).

As a result of experience gained in strict solo-surgery in such circumstances, this concept has now been extended to the elective laparoscopic management of simple adnexal conditions and limited volume uteri. Therefore, it is possible to better gauge the need for an operative assistant and address the financial concerns of operating theaters. The authors published a pilot series of 48 cases in these conditions, and achieved satisfactory results14 with the hand-control interface (Table I).

Finally, if wished, a last possible configuration is to operate with a LAPMAN® and a front assistant in between, using a long version of the shaft, which allows the operator to enjoy camera positioning, auto-control, and image stability provided by the system.

**INDICATIONS IN GYNECOLOGIC SURGERY**

With the currently available interfaces, the size of structures to be operated on and extent of pelvic adhesions may constitute limiting factors that appear to compromise the comfort of
the LAPMAN®. With the new joystick interfaces, however, one can expect these difficulties to resolve with time and practice.

All normal to moderate-size adnexal surgery can, thus, be performed in strict solo-surgery conditions if the need arises; normal-to-moderate uterine pathology (less than 8 to 9 weeks size) and suture-requiring surgery, cases are probably more comfortably treated in the presence of a scrub nurse.

**Conclusion**

Unavailability and variability in quality of human camera holders should not be an obstacle to performing satisfactory laparoscopic surgery. Therefore, some form of standardization of assistance is required and laparoscope-holding systems are a first step in this direction. Substitution for human assistance (with all its economic implications), significant ergonomic benefits (represented by recovery of the visual field control by the surgeon), and image stability are the three main advantages of an efficient laparoscope holder. Intuitiveness of the man-machine interface is also crucial to facilitate a natural and spontaneous response to the surgeon’s command.

The LAPMAN® and then newly developed LAPSTICK® certainly appear to meet all these criteria.

**REFERENCES**