Telesurgery with haptic sensation: The future of surgery

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Michael Stark is the scientific advisor for the EU/SOFAR European Telesurgical Project
“... we believe that any introduction of a new indication for the use of robotic surgery should add value to the existing methods.”

Questions remain on value of robot prostate surgery
By Genevra Pittman
NEW YORK | Thu Sep 6, 2012 4:45pm EDT

(Reuters Health) - Men who get robot surgery for prostate cancer have fewer short-term complications than men whose procedure is done the old-fashioned way - but the newer treatment is pricier, according to a new analysis of close to 30,000 patients.
15 Mar 2013: Robotic Surgery not recommended by largest group of Ob/Gyns
By ConlinMezrano

“There is no good data proving that robotic hysterectomy is even as good as, let alone better than, existing and far less costly minimally invasive alternatives.”

Dr. James Breeden, president of the American College of Obstetricians and Gynecologists said.
Robotic Surgery is all the Rage, But Price is High

Each system ranges in price from $1 million to $2.5 million, and the use of robotic surgery increases the cost of procedures anywhere from $3,200 to $8,000.
... In other cases, the surgical robot seemed to have a life of its own, at times inexplicably cauterizing a fallopian tube, damaging heart tissue, or refusing to let go of a patient's tissue with its grasper.
The cost of robotic surgeries was significantly higher, with a median cost to the hospital of $8,868, compared with $6,679 for laparoscopic hysterectomy.
Comparison of robotic-assisted hysterectomy to other minimally invasive approaches.

Robotic assisted total laparoscopic hysterectomy has comparable surgical outcomes, and possibly decreased blood loss, shorter length of stay, and fewer minor complications than other methods of minimally invasive hysterectomy.

First reported successful laparotomy

Ephraim McDowell 1771 - 1830
20th century: The era of endoscopy

Georg Kelling
1866-1945

Kurt Semm
1927-2003
The 21st century – The era of Telesurgery:
Main claimed advantages of existing telesurgical systems:

1. 3D stereo-vision
2. Dexterity and accuracy
3. Filtration of tremor
4. Improved ergonomy
Main disadvantages of existing telesurgical systems and why improvement is needed:

1. Lack of haptic feedback
2. Efficiency proven for limited indications
3. No access through the pouch of Douglas
4. Difficult access to patient in case of emergency
5. High investment, maintenance and operation costs
The patient’s expectations:

- Accurate diagnosis
- Justified indications
- Safety (checklist, laboratories, available intensive care, etc.)

Optimal surgical tools
In order to answer these expectations and to overcome the disadvantages, an initiative for an improved telesurgical system with haptic sensation has been launched:
A system based on a novel concept, simplicity and efficiency
Advantages of the new system

1. **Haptic sensation**, 3D stereo vision, ergonomic and easy-to-use console

2. Access to the patient is always secured due to the independent arms

3. Optimal for any endoscopic procedure and access from every needed angle
4. Fast docking

5. **Cost-effectiveness**: multi-disciplinarity and low costs due to the possible instruments reusability
Advantages of the new system (cont.)

Assistant-friendly
The importance of haptic sensation
The importance of haptic sensation (cont.)
The importance of haptic sensation (cont.)
The renaissance of abdominal surgery: 
Back to the Fingertips!
Main features of the Telelap Alf-x:

- Extremely short response time < 30 msec
- High sensitivity: 35 g
- Motion scale: 1:1
- Force feedback scale: 1:1
Main features of the Telelap Alf-x:

Remote controlling & haptic sensation
The advantages of tactile sensing

- Tissues are palpable: useful to find hidden lesions, estimate their density and consistency.

- Control of the force exerted while stitching and tying knots, preventing tearing of the sutures, damage to tissues and unnecessary bleedings.
Safety Through Force Control

• No over-extension of the entry site. The point of trocar entry is recognized as the axis to all instruments’ movements.

• Limiting or stopping motion when exceeding programmed force thresholds
1. Zoom function by approaching/retracting the head
2. Any point the surgeon looks at moves to the center of the screen
3. 3D stereo vision – similar to the vision of open surgery
Eye-tracking system (cont.)
Ease of use

- No need to change endoscopic habits
- Short adaptive time
- The system is used as a training tool
• Large range of standard reusable instruments

• Articulated tip instruments

• Any surgical instrument can be adapted to the system
Telesurgery is promising but still need proof through prospective comparative studies

To the editor: With great Interest we read the article “Total laparoscopic hysterectomy versus da Vinci robotic hysterectomy: Is using the robot beneficial?” by Soto et al. (1), which was published in your journal. The introduction of any new surgical system is expected to provide added value for existing ones, and we absolutely accept the conclusion of this excellent article that with experience a totally endoscopic hysterectomy still is superior to robotic surgery. Despite intensive work, telesurgery is probably still in its infancy. In our opinion, the main reason for the long operative time is the lack of haptic sensation and the reliance on visual force feedback. There have been claims that the results of visual force feedback and haptic feedback are comparable (2). In a novel European telesurgical system, the Teleap Airx, the lack of tactile feedback has been overcome, and the surgeon can accurately feel the tuffness of the knots she ties, which makes the telesurgical endoscopic procedure as similar as possible to open surgery. In experimental surgeries that were performed to find out whether haptic sensation will influence the operation time, the average time for cholecystectomy using the Teleap Airx was 21.75 minutes as compared to 29 minutes using a conventional telesurgical system (1). Haptic sensation probably contributed to the self-confidence of the surgeon, who was not dependent on visual force feedback only.

The Teleap Airx system is composed of 1 or 2 consoles and 3 or 4 long arms which enable abdominal or transabdominal access and to move freely around the patient during the surgery. The console supplies open 3D sight and is equipped with an eye-tracking system which moves any point that is looked at to the centre of the screen and Instruments are activated by looking at the respective icon. The system stops movement when the surgeon’s eyes are not fixed at the screen. All Instruments are quickly attached to the arms by magnets and detected on the base of the system to auto-deploy the frusta automatically to avoid obstruction of the incision. The instruments are removable, and 1:1 haptic feedback is transmitted from the tip of the instrument to the surgeon’s fingers when pushing or pulling, enabling to feel tissue consistency and the tension when knotting sutures.

Despite the promising data resulting from our preliminary studies, we insist that telesurgery should have defined indications and should not be used unless prospective comparative studies have proven its superiority over conventional endoscopy.

CONFLICT OF INTEREST

M. Stark is a scientific director of the EU SOFAR telesurgical project. E.R. Morales is a director of robotic department of SOFAR. S. Gidaro is a surgical consultant of robotic department of SOFAR.

REFERENCES


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www.ejgo.org
“Only standardized and optimized surgical methods will allow valuable meta-analysis and enable a comparison of surgical outcome in different institutions and by different surgeons.”

Special Article

The Importance of Analyzing and Standardizing Surgical Methods

Michael Stark, MD*, S. Gerli, MD, and G. C. Di Renzo, MD, PhD

From the New European Surgical Academy (NESA) and the HELIOS Hospital Group, Berlin, Germany (Dr. Stark), and the Department of Obstetrics and Gynecology, University Hospital Monteluce, Perugia, Italy (Drs. Gerli and Di Renzo).

ABSTRACT The outcome of operations performed in different institutions or by different surgeons can hardly be compared if the operative methods are not standardized. Six different vaginal hysterectomy methods were studied. The steps common in all of them were defined. These steps were analyzed for optimal performance and sequence during the operation. The resultant modified method was subjected to a prospective randomized study, which showed that the operation time and the need for pain drugs were reduced. This method was introduced to several departments in different countries. The optimization and standardization of surgical methods are expected not just to improve the postoperative outcome, but also to enable a comparison between different departments and surgeons. Journal of Minimally Invasive Gynecology (2009) 16, 122–125 © 2009 AAGL. All rights reserved.

Keywords: Vaginal hysterectomy; Surgery; Hysterectomy; Vaginal surgery; Vaginal prolapse; Surgical technique; Surgical method
Therefore, the system is introduced together with a suggested optimal surgical logbook designed by opinion leaders in general surgery, gynaecology, urology, etc.
The completed preclinical results: Total Nephrectomy – Learning curve

Table 1. Operation Times and Blood Loss in Experimental Nephrectomies

<table>
<thead>
<tr>
<th>No.</th>
<th>Operation time (minutes)</th>
<th>Blood loss (ml)</th>
<th>SIDE</th>
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<tr>
<td>1</td>
<td>70</td>
<td>&lt; 20</td>
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<td>45</td>
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<td>R</td>
</tr>
<tr>
<td>3</td>
<td>48</td>
<td>&lt; 20</td>
<td>L</td>
</tr>
<tr>
<td>4</td>
<td>52</td>
<td>&lt; 20</td>
<td>R</td>
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<td>5</td>
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<td>R</td>
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<td>8</td>
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<tr>
<td>10</td>
<td>18</td>
<td>&lt; 20</td>
<td>R</td>
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The completed preclinical results: Total Nephrectomy – Learning curve
The completed preclinical results: Cholecystectomy

<table>
<thead>
<tr>
<th>Number of procedures</th>
<th>Number of arms used</th>
<th>Average operation time (min)</th>
<th>Median operation time (min) Conventional telesurgical system</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Described system</td>
<td>Described system</td>
<td>Conventional telesurgical system</td>
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<tr>
<td>4</td>
<td>3</td>
<td>31.75 (30-35)</td>
<td>91</td>
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</table>

The completed preclinical results: Partial nephrectomy

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<th>Number of procedures</th>
<th>Number of arms used Described system</th>
<th>Average operation time (min) Described system</th>
<th>Median operation time (min) Conventional telesurgical system</th>
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<tr>
<td>2</td>
<td>3</td>
<td>115 (110-120)</td>
<td>140</td>
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</table>

The completed preclinical results:
Total Nephrectomy

<table>
<thead>
<tr>
<th>Number of procedures</th>
<th>Number of arms used</th>
<th>Described system</th>
<th>Average operation time (min)</th>
<th>Endoscopy</th>
<th>Average estimated blood loss (ml)</th>
<th>Average operation time (min)</th>
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<tbody>
<tr>
<td>4</td>
<td>3</td>
<td>53.75 (45-70)</td>
<td>&lt; 20</td>
<td>75.7</td>
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Telelap Alf-x - History
CE mark and clinical use
Quick time for docking: first 97 cases
97 procedures in gynecology

<table>
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<th>Surgical procedure</th>
<th>Amount</th>
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<tbody>
<tr>
<td>Ovarian Cyst (enucleation/ovariectomy)</td>
<td>46</td>
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<tr>
<td>Prophylactic bilateral salpingo-oophorectomy</td>
<td>10</td>
</tr>
<tr>
<td>Ectopic pregnancy salpingotomy</td>
<td>0</td>
</tr>
<tr>
<td>Ectopic pregnancy salpingectomy</td>
<td>0</td>
</tr>
<tr>
<td>Infertility and sterility (endometriosis treatment, chromosalpingography)</td>
<td>0</td>
</tr>
<tr>
<td>Myomectomy (single)</td>
<td>3</td>
</tr>
<tr>
<td>Myomectomy (multiple)</td>
<td>0</td>
</tr>
<tr>
<td>Total hysterectomy with bilateral adnexectomy</td>
<td>37</td>
</tr>
<tr>
<td>Total hysterectomy without adnexectomy</td>
<td>11</td>
</tr>
<tr>
<td>Radical Hysterectomy</td>
<td>1</td>
</tr>
<tr>
<td>Eradication of Pelvic endometriosis</td>
<td>1</td>
</tr>
<tr>
<td>Salpingectomy for Tubal inflammatory pathologies</td>
<td>0</td>
</tr>
<tr>
<td>Lymphadenectomy pelvic</td>
<td>10</td>
</tr>
<tr>
<td>Lymphadenectomy aortic</td>
<td>0</td>
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</table>
The Telelap Alf-X simulates open surgery while operating endoscopically. Therefore, it is expected to bring about a renaissance of abdominal surgery.
All surgeries that are performed are monitored by a central (voluntary) registry in Berlin for the exchange of information, avoidance of complications, statistics and publications.
In January 2012, the Telelap Alf-x was approved for clinical use in Europe. The first clinical usage started at the Gemelli University Hospital, Rome in November 2013.
Despite lack of experience, the overall mean docking time of the Telelap Alf-x was 6.2 min in the first 20 cases, as compared to 6.4 min in an existing system.\(^1\)

The first 100 gynecological operations performed using the Telelap Alf-X

The performed operations: adnexal masses, hysterectomies

Overall average surgical procedure time in the first 20 operations: 75 minutes

These numbers are improving constantly.
The advantages of modularity
Thank you for listening.