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Preliminary results of using a voice-controlled robotic camera driver during 3D laparoscopic radical prostatectomy

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Introduction During laparoscopic procedures, the surgeon's control on target field visualization as well as optimal and steady vision can be achieved by using a camera holder. The article presents our preliminary experience with the use of a voice controlled robotic camera holder during 3D laparoscopic radical prostatectomy (3D LRP).

Material and method Thirty patients were prospectively enrolled and underwent either 3D LRP with the use of a voice controlled robotic camera holder (study group) or 3D LRP with the surgeon holding the camera (control group). Oncological, demographic data and surgical parameters were evaluated.

Results Voice-controlled 3D LPR produces a more stable visual field that subjectively decreases the surgeon's fatigue, enables precise preparation, especially along big vessels during lymphadenectomy, urethral stump preparation and urethro-vesical anastomosis. In the fifteen cases analyzed, voice-controlled 3D LRP saved 47 hours of surgeon's time.

Conclusions In this study, the preliminary experience with a robotic arm for camera positioning revealed that the positioner is effective, easy to use and provides a steady and reliable visual field for laparoscopic urological procedures.

Key Words: 3D laparoscopic prostatectomy ‹› prostate cancer ‹› voice-controlled robotic camera

INTRODUCTION

Radical prostatectomy has proven to be the treatment option that shows the most benefit in overall survival and prostate cancer (PCa) specific survival [1]. Minimally invasive techniques like laparoscopy and robot assisted procedures are at least equal to retropubic radical prostatectomy (RRP) in terms of oncological outcomes and superior in terms of blood loss, analgesic requirements, hospital stay and convalescence [2], thus increasingly chosen by patients and their urologists. Laparoscopic radical prostatectomy (LRP) has been developed in some centres, but currently its use is not widespread due to a long learning curve, and the fact that it still remains a technically demanding procedure. Robot assisted radical prostatectomy (RARP), with its well-known advantages, is gradually increasing and displacing all other methods of radical surgical prostate cancer treatment. Nevertheless, the cost of purchasing and maintenance are out of reach for many hospitals and public – financed healthcare systems, making RARP unavailable for many patients. One way to overcome this problem is to translate some of the advantages of RARP to classic laparoscopy. 3D camera systems, which robotic sets are equipped with, are now widely used in pure laparoscopy, overcoming one of the biggest difficulties – two dimensional, plain vision. An operator controlled camera holder, that is standard for RARP, was more or less successfully introduced in classic laparoscopy as a motion controlled or voice activated unit. In traditional laparoscopy, operating surgeons are much more dependent on a camera driver. It requires the

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adequate knowledge and experience of a camera holding assistant as well as good physical stamina to deliver a steady and optimal view on the operating field. In some urological procedures like LRP or laparoscopic radical cystectomy (LRC), the operating team consists of an operating surgeon and two assistant surgeons, which is not economically feasible in some urological departments. Ideally, an operating surgeon should have full control of all instruments and view of the operating field. Fatigue of the camera driver, especially during prolonged procedures, can lead to an increased tremor and requires constant adjustments of instrument positioning from the operator. That can end up with increased frustration and fatigue of all team members as well as prolonged procedure time and increased complication rate. Suboptimal and unsteady vision can also be dangerous in, for example, precise preparation of lymphatic tissue along big vessels. On this basis, numerous passive and active camera holders have been developed to return full camera control to the operating surgeon, providing more steady vision and a reduction in the number of operating team members. Passive systems are usually a kind of frame attached to the operating table which are adjusted manually. A motion controlled, active camera holding system is the EndoAssist® Camera Holding Robot (EndoAssist®; Armstrong Healthcare, High Wycombe, Bucks, UK) that is controlled by the surgeon's head movements and camera arm of the da Vinci® robotic unit. Voice activated camera holding robots are AESOP (Intuitive Surgical, Inc., Sunnyvale, CA, USA) and Viky® (Endocontrol, La Tronche, France) robotic endoscope holding systems activated by voice and pedal.

In this study, we describe our initial experience with 3D LRP using the voice-controlled robotic camera holder system known as Viky. Viky stands for ('Vision Control for endoscopY'). This system consists of a passive dedicated arm attached to the operating table rail, a driver with three motors that is connected to the software unit which analyzes the surgeon's commands and activates motors with the aim of control interfaces: foot pedal and wireless microphones [3]. Viky is a compact device; due to its lightweight construction it can be easily mounted above the patient and requires no floor space.

MATERIAL AND METHODS

The study included two groups of 15 patients undergoing LRP with the use of 3D laparoscope by one experienced surgeon. The first group consisted of patients operated on with the robotic camera positioner Viky® ('Vision Control for endoscopY'), (Endocontrol, La Tronche, France) and the second group was a control group of patients consecutively operated on before the operating theatre was equipped with this new tool. We prospectively collected data for both groups. Both groups were similar in terms of oncological assessment, body mass index and previous operations. In the cases where extended lymphadenectomy was required, the procedure was accomplished transperitonealy. All other patients were operated on through extraperitoneal access. In all cases, the same set of instruments, 0 degree 3D endoscope (Karl Storz – Endoskope, Tuttlingen, Germany) and the same method of ureterovesical anastomosis were used. In the cases with extensive lymphadenectomy, we additionally used a harmonic scalpel (Thunderbeat, Olympus Corporation). We assessed the overall surgery time, number of required lens cleanings, time to set-up the robotic arm, necessity to change the position of the passive arm, ease and precision of scope movement and number of misinterpreted commands. In all extraperitoneal cases, the camera trocar was introduced 2 cm laterally from the umbilicus. After creation of adequate room in the Retzius space, two ports were used on both sides (on the left side 10 mm and 5 mm and two 5 mm trocars on the right side for the assistant). Trocars were placed in a fan shape template with special attention to two medial ports, placed more laterally in cases with the robotic camera holder to provide enough room for its main ring part and to avoid conflict of instruments operating in the medial ports. A special template ring placed over the endoscope port can be used to measure this distance. Importantly, in patients with extensive extra abdominal fatty tissue, the medial trocar should be placed in a caudal rather than caudally medial direction, because the fulcrum of the trocar will then be on the fascial level that can limit movement of instruments in medial trocars. After that, the passive arm is attached to the operating table rail and secured, the ring with motors is fixed to the passive arm and calibration of the system ends the set-up procedure.

RESULTS

The mean age of operated patients was 65.5 (SD 6.5) versus 64.7 (SD 5.51) years in the control group, the average BMI was 28.87 (SD 5.3) versus 28.53 (SD 4.2), and PSA was 9.9 (SD 2.8) versus 8.3 (SD 2.7), thus similar in the robotic endoscope arm group and control group respectively (Table 1 & Table 2). D'Amico's high, intermediate – and low-risk cases were 20%, 33% and 47% for the Vicky group versus 20%, 40% and 40% for the control group. Extensive pelvic lymphadenectomy was performed in 4 cases (26.6%) in each group. The mean opera-

Table 1. *Group of patients (n = 15) who underwent voice-controlled robotic camera driver during 3D laparoscopic radical prostatectomy*

Operation time (hours)	Age at time of surgery	ASA	Smoking status	Weight	Height	BMI	Compli-cations	Lens cleaning nr	Misint. Command	Setup min	cT	Pre-Gleason	PSA	pT	Pos-Gleason	PostN	PostR	No of nodes
4.3	71.0	2	0	92	172	31.10	Rectal injury	2	4	4.41	3b	4+3	35					14
2.9	55.0	1	0	78	176	25.18		0	3	5.20	1c	3+3	6.2					
2.2	62.0	2	1	98	168	34.72		1	3	4.36	2a	3+4	6.2					
3.5	62.0	2	1	98	175	32.00		2	6	5.20	1c	3+3	6.4	2c	4+3	0	0	0
2.8	73.0	2	0	82	174	27.08		0	5	4.00	1c	3+3	7.2	2c	3+4	0	0	0
2.3	72.0	3	1	88	169	30.81		1	3	4.33	1c	3+3	9	2c	3+3	0	0	0
3.7	66.0	0	1	75	168	26.57	Lym-phorhea	0	12	5.33	2a	4+4	11	2c	4+3	0	1	14
3.4	58.0	1	0	78	176	25.18		0	8	4.20	1c	3+3	5.27	2c	3+4	0	0	6
2.8	68.0	1	1	73	171	24.96		2	5	6.00	2b	3+4	14.08	2c	3+4	0	0	8
3.0	66.0	1	0	76	172	25.69		1	4	8.50	2a	3+4	7.6	3a	3+4	0	0	
3.6	53.0	1	0	140	185	40.91		3	3	4,20	1c	3+3	5.2	2c	3+3	0	1	
3.0	67.0	2	2	65	175	21.22		0	12	5.20	1c	3+3	6.1	2c	3+4	0	0	
3.1	64.0	3	2	94	178	29.67		2	4	4.50	2a	3+3	8.9	3b	3+4	0	0	
2.8	73.0	1	0	82	174	27.08		0	6	6.53	1c	3+4	9.4	3a	3+4	0	1	
3.8	73.0	2	0	84	165	30.85		3	10	10.50	3a	4+4	7.2	3b	4+4	1	0	10

Table 2. *Group of patients (control group, n = 15) who underwent standard 3D laparoscopic radical prostatectomy*

Operation time (hours)	Age	ASA	Smoking	Weight	Height	BMI	Pre op stage	Pre op Gleason	Pre op PSA	pT	Post op Gleason	Post N	Post R	Nodes	Lens clean
2.7	59	3	1	130	182	39.25	1c	3+3	8.9	2c	3+3	0	0	0	5
3.2	62	1	1	90	176	29.05	1c	3+3	10.9	2c	3+3	0	1	0	3
2.0	69	2	1	65	164	24.17	1c	3+3	6.9	2c	3+3	0	0	0	2
2.4	68	1	2	76	172	25.69	1c	3+3	7.2	2c	3+4	0	0	0	1
3.3	71	2	0	90	173	30.07	2a	3+4	9.2	2c	3+3	0	0	12	0
3.0	67	1	0	90	174	29.73	1c	3+4	5.4	3a	3+4	0	0	4	2
1.6	68	3	2	70	172	23.66	2a	3+4	8.6	3a	3+4	0	1	2	1
3.8	65	2	0	92	171	31.46	2b	4+3	15.2	2c	3+4	0	0	18	3
2.4	59	1	0	83	173	27.73	2a	3+4	7.8	2c	4+3	0	0	4	1
4.3	56	1	0	84	165	30.85	2a	4+4	8.5	3b	3+4	0	0	16	3
3.7	59	1	0	64	162	24.39	2a	4+3	5.6	3a	4+3	0	0	0	1
2.7	70	1	2	75	170	25.95	1c	3+4	7.2	2a	3+4	0	0	0	0
3.8	65	2	1	100	176	32.28	1c	3+3	5.2	2c	3+3	0	0	2	3
3.3	58	1	0	84	168	29.76	1c	3+3	6.3	3a	3+4	0	1	0	0
3.88	74	2	0	74	176	23.89	2c	4+3	11.4	3b	4+3	1	1	14	2

tive time was 3.1 (SD 0.5) hours in the robotic arm group (extraperitoneal cases 2.7 and 3.6 hours in cases with extended lymphadenectomy) versus 3.0 (SD 0.7) hours (extraperitoneal cases 2.8 and 3.8 hours in cases with extended lymphadenectomy). The mean number of required lens cleaning due to inadvertent endoscope contact with tissue, excluding needs of lens cleaning due to fogging or accumulation of coagulation gasses, was 1.13 in the robotic arm and 1.8 for the control group. The mean set-up time for the device was 5.5 minutes (SD 1.2) but in the control group, there was additional time to set-up arm supports for the camera operating assistant which approximately took about 5 minutes, and this time was not added to the total surgery time. The average number of cases of misinterpretation of commands or lack of action after commands was 5.87 (range 3 to 12) and this issue can probably be improved by adequate and precise personal profile recording and attention not to obstruct device wires as this can hold arm movement. We also noticed isolated episodes of robotic arm movement without adequate commands. The reason for that was probably misinterpretation by the device of conversation in OR as a command. The disease was organ confined in 10 cases operated with the robotic arm (66%) versus 9 cases (60%) in the control group, while the positive surgical margin (PSM) rate was 20% versus 26%. Nodal involvement was diagnosed in one case for each group (6.6%). There was no need for blood transfusion or conversion to open surgery in either group. In the study group, one patient with cT3a disease had a rectal injury that was sutured laparoscopically and resolved without sequel, while in the control group, one case of prolonged anastomotic leakage and one case of prolonged lymphorhea appeared. In one case with a BMI of 34.7, operated with the use of a robotic camera positioner, there was a need to switch to human assistant endoscope driver due to the collision of the robotic ring with middle ports. Small readjustments of the passive arm due to a collision with the optic port was needed in three cases.

DISCUSSION

At the end of the twentieth century, before robotic laparoscopy took over a significant part of the minimally invasive surgery, some studies evaluating laparoscopic camera control devices or comparing different types of such solutions were made. Most of these studies concluded that a robotic camera driver can safely replace one of the surgical assistants and underlined that those devices can provide a more steady visual field with fewer unwanted or aberrant camera movements [4, 5]. Wagner et al. [6] compared the first, and probably most broadly used voice controlled system, AESOP, with the head motion controlled system EndoAssist, concluding that although both devices provide complete control of the desired view without relying on an assistant, the later device has some disadvantages, like a large profile, lack of table-mounted design and need for pedal activation. Robotic endoscope positioners were also used in other surgical specialties. Den Boren et al. [7] has tested two different robotic instrument positioners during elective cholecystectomies and concluded that in the questionnaire, most surgeons preferred an instrument positioner to a human assistant. In a series of gynecological patients, the authors agreed with most previously mentioned advantages of an active camera holder and noticed a reduction of postoperative pain in a study group, probably due to reduced laparoscope movements and diminished strain in the umbilicus [8]. Authors from the EAU Section of Uro-Technology (ESUT) called such a set of instruments a laparoscopic robotics suite and expressed their opinion that it can be a real democratization of robotic surgery [9].
Of note, the scope movements throughout the whole procedure are controlled by the surgeon through the ear mounted wireless microphone or sometimes, the assistant can help in scope positioning with the use of a foot pedal. The surgeon can use pre-programmed commands or a personal unique voice profile can be prepared and saved in the device before the surgery. We have noticed that although the device is equipped with Polish commands, the recognition of an English personal profile is more precise and sensitive. Moreover, the system will not misinterpret its commands with dialogue in Polish in the operating room. The device can save up to four positions that can be especially helpful while urethrovesical anastomosis is performed and a number of the same forward and backward scope movements are needed.
Importantly, both groups were comparable in terms of demographic, body mass index and oncological features and no objectively measured differences were noticed between those groups. Subjective opinion of the surgeon was that endoscope control with the robotic arm is more predictable than with hand control. The surgeon can achieve an exact and expected visual field with most commands and therefore does not need to readjust his movement. Lack of physiological tremor, usually increasing with the time of the operation, produces a more stable visual field that subjectively decreases the surgeon's fatigue, enables precise preparation, especially along big vessels during lymphadenectomy, urethral stump preparation and urethro-vesical anastomosis. The 3D laparoscopic camera that we used is significantly heavier than other 2D endoscopes and produces much more heat that additionally can cause discomfort for the human assistant, making a robotic driver even more desirable. In most cases, the Viky system did not compromise surgical performance. In the fifteen analyzed cases of LRP the Viky system saved 47 hours of the surgeon's time.

CONCLUSIONS

Traditional laparoscopy remains, in some centres, the best possible minimally invasive option and laparoscopy surgeons are still gaining some ideas from robot-assisted surgery. Some new devices are introduced to classical laparoscopy to make these procedures less demanding.
In this study, the preliminary experience with a robotic arm for camera positioning revealed that the Viky endoscope positioner is effective, easy to use and provides a steady and reliable visual field for laparoscopic urological procedures. While this assessment seems promising in the economical aspect, further analysis is being prepared on a larger group of patients and for various urological minimally invasive procedures.

CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

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