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Influence of a Robotic Camera Holder on Postoperative Pain in Women Undergoing Gynaecological Laparoscopy

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Abstract. *Aim: To investigate the influence of a robotic camera holder on postoperative pain in women undergoing gynaecological laparoscopy. Patients and Methods: Sixty-one women were prospectively enrolled in the study and underwent either conventional laparoscopy or laparoscopy using an active camera holder. Twenty-four and 48 h after surgery abdominal pain was assessed using the short form of the McGill Pain Questionnaire. Demographic data, and clinical and surgical parameters were evaluated. Results: Twenty-seven women underwent laparoscopy with an active camera holder (study group) and 34 women underwent laparoscopy with human camera assistance (control group). Women in the study group were older (43.5±8.6 vs. 37.4±10.4 years; p=0.018) while the duration of surgery was shorter in women who underwent conventional laparoscopy (97±37 vs. 71±33 min; p=0.005). Total pain scores 24 h (28.3±24.2 vs. 44.0±35.0; p=0.049643) as well as 48 h (18.0±20.0 vs. 33.8±31.0; p=0.016) after surgery were significantly less in the study group. Conclusion: The usage of a robotic camera holder results in less postoperative pain in women undergoing gynaecological laparoscopy.*

Over time, laparoscopic surgery has evolved into the standard procedure for treatment of most benign, as well as many malignant gynaecological diseases. In conventional laparoscopic procedures, the camera is held and directed by the assisting physician, whereas the surgeon uses both hands to handle the laparoscopic instruments. During surgery, possibly lasting several hours, manual control of the camera system can be exhausting for both the assistant as well as the surgeon, who needs a stable image to perform surgery efficiently and accurately. An unsteady camera image reduces the performance of goal-directed hand movements and undesired camera movements of the assistant interfere with focusing attention during surgery (1). Therefore, different passive and active camera holders have been designed and there are some investigations dealing with the functionality and safety of these devices (1-3). Static camera fixation eliminates physiological tremor due to fatigue of the camera-holding assistant and prevents drifting from surgical focus. Furthermore, static devices lead to a stable image and result in a reduction of required lens cleanings, significant less contact with adjacent organs and less inadvertent movements or rotations (1, 4). The umbilical incision in which the camera is inserted plays an important role during conventional laparoscopy and occupies a special status in minimally-invasive surgery. On the one hand, for physicians, the umbilicus as the thinnest part of the abdominal wall containing few blood vessels, muscles and nerves, seems to be a particularly suitable region for access into the abdomen. On the other hand, from the patient's point of view, 43% of women undergoing gynaecological surgery would preferably avoid umbilical incision, if possible (5). There are a few published studies comparing conventional with robot-assisted laparoscopy, but only one focused on postoperative pain as the primary outcome and, to the best of our knowledge, no study exists dealing with the effect of an active camera holder on postoperative pain after gynaecological laparoscopy (6). We, hence, performed this investigation to analyse if a robotic camera holder reduces postoperative abdominal pain in women undergoing gynaecological laparoscopic surgery.

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Patients and Methods

Between 05/2012 and 03/2013, 61 women were included in the current study. The results reported for this investigation are a

Table I. *Demographic and surgical parameters of the study and control groups.*

Variable	Study group (N=27) Mean±SD	Control group (N=34) Mean±SD	Independent *t*-test	*p*-Value
Age (years)	43.5±8.6	37.4±10.4	2.42	0.018
BMI (kg/m^2)	27.0±6.5	34.0±6.0	2.00	0.200
Duration of surgery (minutes)	97±37	71±33	2.94	0.005
Overall hospital stay (hours)	62.7±12.2	58.8±11.0	1.32	0.193
Blood loss (ml)	84.1±125	41.2±121	1.36	0.180
Time for mobilisation (hours)	5.1±2.3	6.4±3.5	1.69	0.097

BMI: Body mass index; SD: standard deviation.

subgroup analysis of a prospective randomised study of our Department dealing with an innovative analgesic approach after gynaecological laparoscopy. All patients underwent gynaecological laparoscopic surgery due to benign causes at the University Medical Center Mannheim, Heidelberg University, Germany. Institutional Review Board approval was obtained for this study (MA-2012-4). Written informed consent was obtained from all participating women. Exclusion criteria were malignant gynaecological disease and conversion to laparotomy. An age less than 18 years and regular analgesic medication were also exclusion criteria. All laparoscopic surgeries were performed under general anaesthesia as a standardized procedure. A 10-mm optic trocar was inserted beneath the umbilicus and two 5-mm trocars were placed laterally in the lower abdomen. Intraoperative pressure was 15 mmHg maximum. In cases of laparoscopic supracervical hysterectomy (LASH) and laparoscopic fibroid resection, the left incision in the lower abdomen was extended to 12-15 mm to introduce a morcellator. In the study group, the endoscope was handled by a robotic arm system attached to the operating table (Einstein Vision System; B. Braun, Aesculap AG, Tuttlingen, Germany). This 16 kg robotic arm comprises of a three-joint aluminium structure. It was mounted preoperatively on the right hand side of the operating table and covered by a sterile cover. The assisting nurse or an assisting physician, controls the camera movement based on the surgeon's instructions via remote control. In general, the camera can be moved left, right, up, down, forward and backward. For each procedure, common laparoscopic instruments (B. Braun) were used. The control group underwent conventional laparoscopic surgery with a human camera-holding assistant, all residents experienced in laparoscopic surgery.

The patients received analgesics on demand according to a standardized escalating pain management scheme, starting with non-steroidal anti-inflammatory drugs (NSAID) and ending with opioids. Pain medication on demand was given as follows (in brackets, maximum dosage per day): 500 mg paracetamol (4 g), 75 mg diclofenac resinat (150 mg), 400 mg ibuprofen (1200 mg). In cases of insufficient analgesia with these agents 50 mg pethidine hydrochloride or 7.5 mg piritramide were applied additionally.

The principle outcome parameter was postoperative pain 24 and 48 h after surgery. Secondary end-points were length of hospital stay, need for additional medication for pain relief, and time to mobilisation after surgery. The questionnaire for pain evaluation used was the Short-Form of the McGill Pain Questionnaire (MPQ-SF), which contains three sections: a list of 15 pain-describing terms recording the intensity of types of pain experienced, an analogue scale, and a six-point Present Pain Intensity Index (PPI) (7). The pain describing section (McGill 1) is divided into 11 sensory pain descriptors and four affective pain descriptors with a 0 to 3 scale (marked 'none', 'mild', 'moderate', and 'severe'), so that potential score ranges were 0 to 33 and 0 to 12. The second section (McGill 2) of the questionnaire is an analogue scale ranging from 0 to 100, indicating no pain to worst possible pain. The third component (McGill 3) is a six-point PPI with the following scores: 0=no pain, 1=mild pain, 2=discomforting, 3=distressing, 4=horrible, 5=excruciating. The scores of these three sections are added in order to obtain a total score with a range from 0-150 (McGill total).

Statistics. All data were recorded in an Excel datasheet prospectively. Arithmetic means and standard deviations were calculated. Statistical analysis was carried out on the scales of the measurement with independent Student *t*-test (two-tailed) and Pearson's Chi^2 -test. McGill scores were analysed with a 2×2 repeated-measure analysis of variance with the independent factor 'group' (control group, study group) and the repeated-measurement factor 'time' (assessment 24 h and 48 h post surgery). Statistics were calculated using SPSS statistics software (IBM SPSS Statistics 20; IBM Corporation, 2011, Armonk, New York, USA). A *p*-value below 0.05 was considered statistically significant.

Results

There were some statistically significant results concerning the demographic and surgical parameters in both groups. Women in the study group were significantly older compared to patients in the control group (43.5±8.6 *vs.* 37.4±10.4 years; t=2.4, p=0.018) and duration of surgery was less in women who underwent conventional laparoscopy (97±37 *vs.* 71±33 minutes; t=2.9, p=0.005). Body-mass index, blood loss, overall duration of hospital stay and time-to-mobilisation were not statistically significantly different between the groups (all p>0.05), as shown in Table I. The most frequently performed surgery in the study group was laparoscopic hysterectomy (13/27; 48%), while in the control group it was adhesiolysis (10/34; 29%) (see Table II). Statistical analysis of postoperative pain assessed by the MPQ-SF revealed significant main effects of the factors group [F(1.59)=5.1, p=0.028] and time

Table II. *Surgeries performed in the study (n=27) and control (n=34) groups.*

Variable (n)	Study group n (%)	Control group n (%)
Laparoscopic hysterectomy (18)	13 (48)	5 (15)
Uterine fibroid resection (7)	2 (7)	5 (15)
Salpingo-oopherectomy (13)	7 (26)	6 (18)
Ovarian cyst exstirpation (6)	3 (11)	3 (9)
Adhesiolysis (12)	2 (7)	10 (29)
Resection of endometriosis (2)	0 (0)	2 (6)
Extrauterine gravidity (2)	0 (0)	2 (6)
Tubo-ovarian abscess (1)	0 (0)	1 (3)

Multiple procedures per patient were possible.

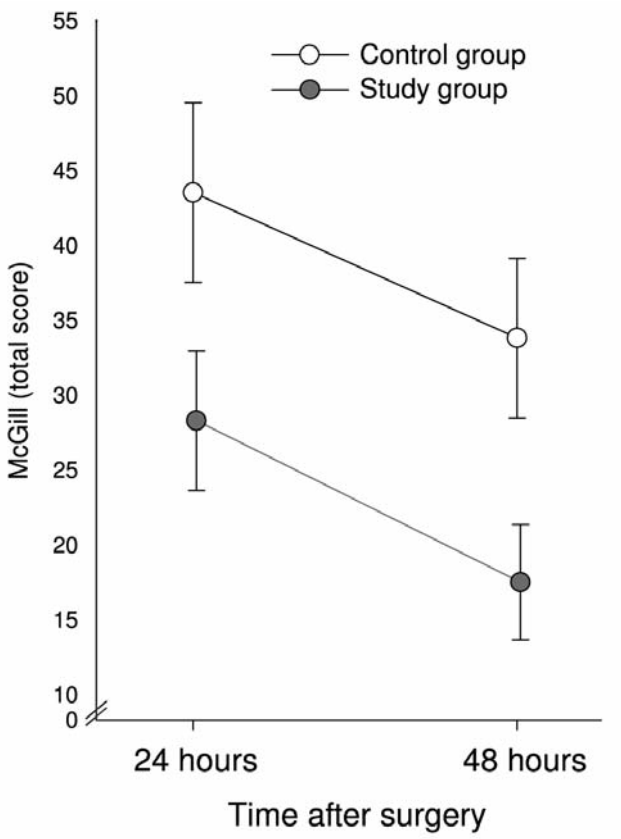

Figure 1. *Postoperative pain scores (mean and standard error) assessed by the short-form of the McGill Pain Questionnaire at 24 and 48 hours after surgery.*

[F(1.59)=18.0, $p<0.001$], however no interaction effect between these factors was observed [F(1.59)=0.1, $p=0.825$]. In the study group, the total McGill pain scores 24 h (28.3±24.2 *vs.* 44.0±35.0; $p=0.05$) as well as 48 h (18.0±20.0 *vs.* 33.8±31.0; $p=0.016$) after surgery were significantly lower compared to those of the control group (Figure 1). In both groups, pain decreased comparably with the course of time. In order to evaluate the influence of age on pain experienced after surgery, we calculated correlation coefficients separately for both groups, correlating age and McGill scores. Results revealed no statistical significant covariation and showed no differences comparing both groups (all $p>0.05$). There was also no significant difference regarding necessity for postoperative pain medication (NSAID) comparing both groups. In the study and in the control group 74% and 91% of women, respectively, received postoperative pain medication ($\chi^2=3.2$, $p=0.072$). A detailed description of the non-opioid pain relievers applied is given in Table III. Groups did not differ with regard to post-operative pain medication except for paracetamol, which was given more often in the control group during the first 24 h after surgery. One woman of the study collective received an opioid pain reliever (7.5 mg piritramid *i.v.* within the first 24 h after surgery).

Discussion

The interest and use of robots in minimally-invasive surgery have increased notably. Using camera holding systems in laparoscopic surgery provides an optimised and more stable image compared to human camera assistance (1). There are few reports dealing with the feasibility, advantages and disadvantages of different types of laparoscope holders. These showed an advantage in favour of robotic camera holders regarding the duration of surgical procedures in phantom models (8-10). There are few reports concerning clinical experience with different camera holders; they state that their use is feasible, safe and that the number of camera cleanings is reduced (1-3). Data on the effect of robotically assisted laparoscopy on postoperative pain are scarce. Previous studies showed that pain after laparoscopic surgery can be subdivided into three categories, which are visceral, parietal and shoulder tip pain (due to overstretching the diaphragm or ligaments of the liver) (11, 12). Of these three categories, parietal pain, hence pain due to incision of the abdominal wall, is known to dominate over the other possible pain components (13, 14).

Regarding postoperative pain after minimally-invasive surgery, Bencsath *et al.* showed that the umbilical port site seems to be the most painful one (15). Furthermore, in a previous investigation of our Department we found that 43% of women undergoing gynaecological laparoscopy would avoid umbilical incision if possible (5). Hence, the incision in the umbilical region, known to be the thinnest region of the abdominal wall, containing only few vessels and nerves, in which the largest trocar and laparoscope are inserted, seems to occupy a special status compared to other incisions

Table III. *Necessity for postoperative non-opioid pain medication in the study (n=20; 74%) and control (n=31; 91%) collectives.*

Substance	0-24 h Post-surgery n (range of dose in mg)			24-48 h Post-surgery n (range of dose in mg)		
	Study group	Control group	Test-statistics	Study group	Control group	Test-statistics
Diclofenac	13 (75-300)	9 (75-300)	χ^2=3.1 p=0.080	12 (75-150)	14 (75-300)	χ^2=0.1 p=0.798
Novalgin	5 (750-1000)	5 (750-1500)	χ^2=0.2 p=0.690	3 (1000-3000)	2 (750-2000)	χ^2=0.6 p=0.460
Ibuprofen	3 (400-800)	3 (400-800)	χ^2=0.9 p=0.766	1 (800)	6 (400-800)	χ^2=2.9 p=0.090
Paracetamol	3 (500-1000)	16 (500-2000)	χ^2=9.1 p=0.003*	2 (500-1000)	5 (500-2000)	χ^2=0.8 p=0.374

used during minimally-invasive surgery. In general, from the patient's point of view, the cosmetic result after laparoscopic surgery is not as important as some physicians may believe and is less important than pain, risk of complications, surgical success, convalescence, costs or return to activities of daily life (5). Although minimally-invasive surgical approaches lead to pain reduction compared to conventional surgery, we know that 30% of patients undergoing laparoscopic surgery suffer moderate or severe pain 24 h postoperatively, and up to 80% of the patients require opioid analgesics (16, 17). This should be considered by gynaecological surgeons in particular, as female gender and surgery for benign diseases are risk factors for the development of post-surgical chronic pain (18). Apfelbaum *et al*. found that severe postoperative complications, such as coronary ischaemia, deep venous thrombosis and pulmonary embolism, are related to ineffective pain management after surgery (19).

Taking this into account, it is not surprising that an effective pain management leads to a reduction of complications after surgery, a faster hospital discharge, less resource utilisation and hence lowered direct and indirect costs (20). Due to the obvious importance of minimising postoperative pain, there studies investigating different intra- and postoperative analgesic schedules, such as intraperitoneal and intravenous application of local anaesthetics or topical patches for postoperative pain relief (21-23). Robotically-assisted laparoscopy has been investigated in a few studies focusing on postoperative pain. Results however, are inhomogeneous. On the one hand, after robotic laparoscopic sacrocolpopexy, women had higher visual analogue scale pain scores at rest and with normal activities after surgery compared to those undergoing conventional laparoscopy, but on the other hand, in a recently published prospective randomised trial by the same authors comparing conventional and robotically-assisted total laparoscopic hysterectomy, the postoperative pain scores did not show any statistically significant differences (24, 25). In another non-randomised study, El Hachem *et al*. investigated postoperative pain after robotically assisted gynaecological laparoscopy as the primary outcome parameter (6). In the present study, the postoperative pain scores were evaluated using a 10-point numeric rating scale, which did not show any significant differences comparing robotically-assisted to conventional laparoscopy. Robotically assisted interventions had a significantly longer operating time, duration of hospital stay and later return to daily activities compared to conventional laparoscopy. In contrast to this investigation, we found significantly less postoperative pain scores after laparoscopy using an active camera holder. This is consistent with the results of a recently published retrospective case control study analysing postoperative pain in women who underwent robotic *versus* traditional laparoscopic hysterectomy (26). Major drawbacks of the investigation of El Hachem *et al*. and our study are significant differences concerning age, a non-randomised design and inhomogeneity of surgeries performed and duration of surgeries comparing both collectives. A potential influence of age on postoperative pain was precluded by regression analysis, as explained above. In our study, the duration of surgery was significantly longer and the number of greater ablative procedures (laparoscopic hysterectomy) with the introduction of a morcellator was significantly higher in the study collective, which hypothetically might lead to increased postoperative pain. However, pain after surgery was significantly less in the study group. The fact that paracetamol was given significantly more often within 24 h after surgery in the control group strengthens our thesis that an active laparoscope holder might reduce postoperative pain. Potentially, prolonged duration of anaesthesia, with application of more analgesics, could be the reason for a

lower immediate postoperative pain but not for lower pain scores 48 and arguably 24 h after surgery.

Summarising, data about pain after robotic-assisted laparoscopy are inconsistent. In contrast to feasibility reports of robotically-assisted laparoscopy, studies dealing with patient-centered parameters, such as postoperative pain, are scarce. Reasons for the reduction of postoperative pain in our investigation might be a consequence of reduced laparoscope movements and a diminished strain of the umbilicus due to fewer camera cleanings and hence less re-insertions of the laparoscope into the abdomen. We are aware of the limitations of our study. Both groups differ with regard to age and type of performed surgeries. Nevertheless, we show that age had no influence on postoperative pain. Furthermore, there were differences comparing both collectives concerning the duration of surgeries. Our results stress that the use of an active camera holder might lead to reduced postoperative pain after laparoscopic surgery. In order to improve patient care, it is necessary to provide adequate pain management and, more importantly, to avoid procedures that cause increased postoperative pain. Further prospective randomised studies concerning this topic are needed.

Conflicts of Interest

The laparoscopic device was provided by Aesculap (Tuttlingen, Germany) for the Department of Obstetrics and Gynaecology, University Medical Centre Mannheim, Heidelberg University, Germany for one year without costs for clinical evaluation.

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