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SCIENTIFIC LITERATURE ON AESCULAP® 3D *EinsteinVision*® / 3D TECHNOLOGY

Experience Reports

MIRKO OTTO

3D LAPAROSCOPY - USE IN BARIATRIC SURGERY

1. INTRODUCTION

Mannheim University Medical Center, as a maximum care hospital, provides a wide range of diagnostic and therapeutic services. Including part-time staff, around 4,800 employees at around 30 clinics and institutes care for around 76,000 inpatient and day-care patients as well as approximately 210,000 outpatients annually.

The surgical clinic offers the complete range of visceral, chest and vascular surgery as well as bariatric surgery. With 136 beds, over 40 physicians and a comprehensive diagnostic and therapeutic service, the surgical clinic is the largest department at Mannheim University Medical Center. Since 2003 we have been carrying out more and more bariatric operations and endoscopic procedures. Annually, we perform around 100 bariatric procedures.

2. BARIATRIC PROCEDURES

The number of bariatric operations is increasing worldwide, in particular due to the lower mortality rate in operated patients compared to non-operated obese patients[1]. There is also growing evidence of a beneficial effect on concomitant diseases such as diabetes and hypertension[2,3].

As a global comparison, the number of operations per 100,000 inhabitants in Germany is only 11, compared to approx. 130 in the USA. Even in Sweden, a country with a significantly lower average BMI among the general population, approximately 90 operations / 100,000 inhabitants are carried out. In this context, there seems to be a clear need to increase the number of bariatric operations in Germany[2,4].

The bariatric operations performed fall mainly into two types: laparoscopic sleeve gastrectomy (LSG) and laparoscopic Roux-en-Y gastric bypass (RYGB). The currently available data shows that the two procedures are equivalent to one another, at least in the initial post-operative years[5]. There is currently no long-term data for the subsequent years. There is a loss of around 60-70% of the overweight and a clear improvement in concomitant diseases.

These two procedures also account for the majority of the bariatric operations performed at our clinic as well, as we can achieve good results with lower morbidity with these procedures. Based on the available long-term data (over 10 years), we first recommend the RYGB if there are no contraindications. Contraindications include chronic inflammatory bowel diseases, conditions following kidney transplantation with significant medication dependency and prior major intestinal surgery.

The number of additional procedures with evidence of good effectiveness is increasing. So, the single-anastomosis gastric bypass (omega loop), the biliopancreatic diversion with a duodenal switch (BPDDS) and even the gastric band should not be left unmentioned.

The omega loop is a real alternative for patients with a BMI of 50-60 kg/m^2 as it leads to better weight loss compared to the two traditional procedures. Unfortunately, the development of a gastric stump carcinoma cannot be ruled out, which is why young patients should be advised against undergoing this procedure[6].

For very heavy patients (BMI > 65 kg/m^2), often only one multistage process is considered. After initial sleeve gastrectomy, BPDDS seems to the have the best weight loss results with a concomitant excellent effect on any possible diabetes. Quality of life, measured using a questionnaire (BAROS) on physical, social and psychic effects is significantly improved after the operation, despite the malnutrition caused by the operation[7].

The gastric band provided excellent data in an Australian study. However, the requirement for intensive follow-up care, which is not paid for in Germany, is problematic. Therefore, this procedure is rare both in Germany and at our clinic[8].

Different methods can also be combined in individual cases, e.g. the fitting of a gastric band to an existing gastric bypass (laparoscopic banded Roux-en-Y-gastric bypass). However, this should be a strictly exceptional indication as there is no long-term data available, there are no prospective randomized superiority studies and the negative effects of a foreign body are already known about from the traditional gastric band.

Every indication and each surgical procedure requires an individual decision, agreed with the patient. From our perspective, the good long-term data and good tolerability of LSG and RYGB support the use of these procedures. A general recommendation for the other methods cannot be given due to the lack of evidence regarding their equivalence.

3. LAPAROSCOPIC ROUX-EN-Y GASTRIC BYPASS

65% of our patients undergo an RYGB. First of all, we insert a 12 mm camera trocar under visual control without prior creation of a pneumoperitoneum. Then two 12 mm trocars and two 5 mm trocars are introduced by sight and we start the measurement of the biliary limb (section of the small intestine from the duodenum to the subsequent Roux-en-Y anastomosis), which is marked 60 cm after the ligament of Treitz.

The limb lengths are still being discussed as current studies seem to show that there are advantages to a longer biliary loop. However, we are still waiting for prospective, randomized long-term data[9].

A 6-7 cm-long and narrow gastric pouch with a fill capacity of 20 ml is formed. To do this, a linear stapler is applied from the small curvature at a right angle. Then two further magazines are applied longitudinally up to the angle of His.

The posterior wall of the gastrojejunostomy is also attached using a linear stapler and the anterior wall suture is made using a continuous suture technique, with a gastric probe (28 Charrière) inserted for anastomosis calibration. We the check that the anastomosis and the stapled suture is tight by filling the stomach with indigo carmine.

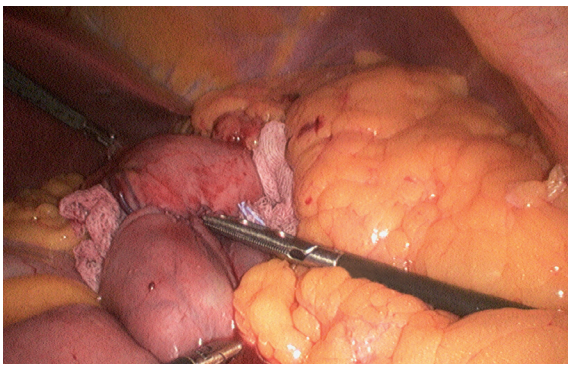

Figure 1: Indigo carmine test following gastrojejunostomy

The alimentary limb (section of the small intestine from the gastric limb to the Roux-Y anastomosis) is set at 150 cm. We always close the jejunojejunal defect with non-absorbable suture material. Various studies[10] show the superiority of closing both this defect as well as Petersen's space (between the colon and the pulled down alimentary limb).

The jejunojejunal anastomosis is created with three linear stapler magazines. First, two magazines are applied in opposing directions. These create a sufficiently large anastomosis, which is then closed transversely with an additional magazine. A fascial suture is

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not used and after the draining of the capnoperitoneum, the trocar accesses are cutaneously sealed.

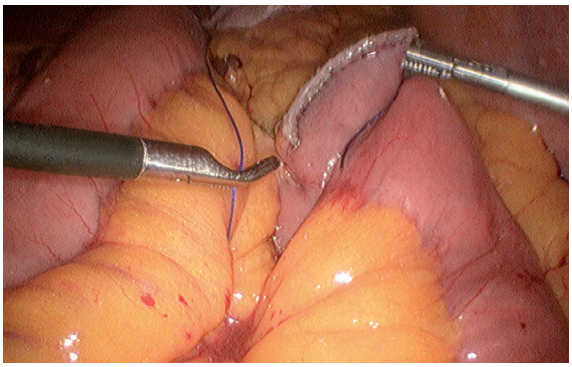

Figure 2: Closure of the mesocolon opening after stapling of the jejunojejunostomy

4. 3D TECHNOLOGY (EinsteinVision®)

Using 3D technology we have been able to significantly shorten the duration of the operation in recent years. Laparoscopic suturing is made significantly easier and leads to less surgeon fatigue. The three-dimensional imaging enables threads, needles and tissue to be reached quickly and unerringly. The stitch direction and the angle of the clamped needle can be seen clearly. Procedures with a significant suturing aspect, such as RYGB and BPDDS, benefit in particular from the 3D system. It should be noted that the EinsteinVision® (12 mm) camera lens does not fit through every manufacturer's 12 mm trocars, so a suitable system must be found in this regard. Alternatively, a 15 mm trocar can also be used.

5. CONCLUSION

As the currently available data shows, the surgical bariatric procedures are clearly superior to conservative treatment of overweight. Therefore, the number of these operations is also increasing in Germany. New technologies, like the 3D technologies, that simplify these operations and have a positive effect on the cost-benefit ratio and a lower surgical risk for patients due to the shorter operating time, are also contributing to this increase in case numbers.

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THE 3D LAPAROSCOPY - NEW TECHNOLOGY ON TRIAL

1. INTRODUCTION

The University of Cologne Clinic and Polyclinic for General, Visceral and Tumor Surgery offers the full range of general and visceral surgery. It also provides transplant - kidney, pancreas and liver - surgery, surgery for morbid obesity and pediatric surgery. Proctology and several consultation clinics complete the spectrum. As a supra-maximal care hospital, our clinic is able to provide adequate interdisciplinary treatment to even the most severely injured patients around the clock.

The treatment of tumors along the entire digestive tract and in the endocrine glands is one of our specialties. The center has an international reputation as a center of excellence for the treatment of the esophagus and the stomach.

Patients are cared for by a medical team consisting of a director, 8 senior physicians, 20 specialists and assistant physicians.

Treatment takes place within an interdisciplinary framework - both bedside and at joint meetings. The patient is always the most important person and an individualized therapy tailored to their needs and based on the latest scientific knowledge is always the basis of the treatment. We contribute to expanding this knowledge with the clinic's own research. We transmit this knowledge to medical and non-medical professionals in the teaching provided by the clinic.

2. POTENTIAL USES

The potential uses of EinsteinVision® 3D are essentially the same as the current (2D) laparoscopy. Image resolution and image display enable the use of 3D EinsteinVision® in all operations that were previously performed in 2D. However, the lower level of detail from the enlargement of the 3D EinsteinVision® requires an initial adjustment. This can be particularly difficult at the start, particularly for surgeons who have less experience of laparoscopies. In this regard, a zoom option would be desirable and certainly technically feasible in the future. [Editor's note: The idea was taken up by Aesculap and implemented in the form of an electronic zoom]
You also have to accept a change of perspective from a 30° camera angle with the Einstein 3D, as a 30° angle is not possible with the 3D camera system. However, the camera can be rotated 180°. You get used to wearing the 3D glasses and using a single, but large, 3D monitor with no problem. The monitors permanently installed in the operating theater are, at least in our clinic, not compatible with 3D and can therefore only show the image in two dimensions. However, even this did not have a disruptive effect.

As the cost of using EinsteinVision® 3D does not differ from the other 2D laparoscopic systems, we have successfully used EinsteinVision® 3D for almost all the operations carried out at our clinic, from laparoscopic appendectomies to thoracoscopic esophagectomies.

3. USES AND ADVANTAGES FOR USERS

After a short adaptation phase, handling the 3D EinsteinVision® is very easy. The special sharpness of the image on the large monitor is very impressive and advantageous. Thanks to the 3-dimensional imaging of even the smallest anatomical structure and deep into the site,it is possible to dissect the anatomical structures precisely and exactly and to insert and knot fine sutures intracorporeally. In our experience, in particular for laparoscopic gastrolysis (mobilization of the stomach in the context of esophageal resection in esophageal cancer) operations, which we perform very frequently at our clinic, the delicate dissection of the lymphadenectomy along the celiac trunk, the common hepatic artery and the lienal artery and the dissection of the vascular arc on the large curvature side was extremely useful thanks to the 3-dimensional imaging and the very high image resolution. As a result, a systematic and complete lymphadenectomy can be performed very safely in this area. In other operations as well where precision is very important when performing the dissection because the surrounding structures can be damaged very easily, using the EinsteinVision® 3D again provides significant advantages.This expands the indication for 3D laparoscopic operations for corresponding conditions. As an example, the intraoperative site of a patient with a leiomyoma of the upper thoracic esophagus measuring 8x6x2 cm that was removed using EinsteinVision® 3D is shown (see Figure 1). During this dissection max-imum caution is required due to the fine adhesions of the leiomyoma to the esophageal mucosa and the resulting danger of a perforation, as well as the narrow topographical relationship with the pars membranacea of the trachea, the vagus nerve and the thoracic duct.

In diseases such as achalasia, the 3D camera is also a big advantage for the laparoscopic dissection of the esophageal mucosa during a myotomy. Thanks to the excellent image, the operation is, in our experience, also made significantly less tiring and stressful for the surgeon.

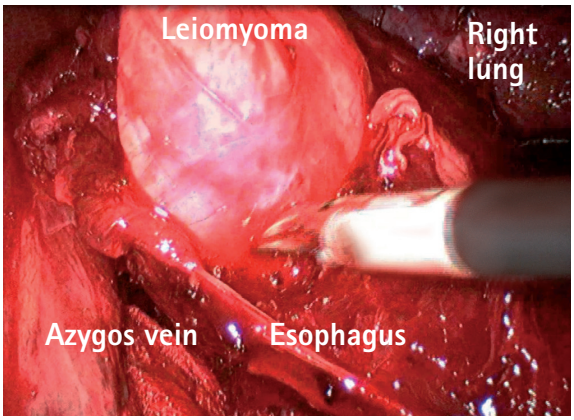

Fig. 1 Intrathoracic site for the enucleation of a large esophageal leiomyoma

4. USES AND ADVANTAGES FOR PATIENTS

Einstein Vision® 3D naturally benefits patients undergoing laparoscopy and thoracoscopy due to the increased safety of the operation. Firstly, thanks to the technical superiority of 3D imaging during delicate dissection of fragile and sensitive structures, there are technical options that previously could maybe only be attained using open surgical techniques and magnifying glasses. In addition, patient safety is further increased by the ability to spatially control the dissections and actions precisely. In particular, in tumor surgery, Einstein Vision® 3D makes a safe resection of the primary tumor and the lymphatic drainage area along the vessels possible.

5. BENEFITS FOR THE CLINIC

Using Einstein Vision® 3D has resulted in a well-rounded concept for the clinic. Thanks to the 3D laparoscopy

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and thoracoscopy, today our clinic can offer state of the art minimally invasive surgery. Procurement costs are an acceptable strain on the budget because the operating costs remain the same. Using sterile protective film over the camera and camera cable means that the camera does not have to be sterilized and that it is not necessary to purchase several cameras. There is still no statistical evidence of the reduction in postoperative complications as a result of using Einstein Vision® 3D and so this decrease is still speculative.

6. ADVANTAGES FOR TRAINING AND ADVANCED TRAINING

The visualization of anatomy and the pathological findings in situ is a unique experience for students in training as well as for medical technicians in advanced training. The surgical and anatomical relationship is easier to understand and can be grasped quicker by students with 3D operations. Using Einstein Vision® 3D is particularly advantageous for inexperienced physicians or physicians who are less able to deduce the three-dimensional (= real) situation from a 2D image.

7. CONCLUSION

In summary, we can report a lot of positive experiences and only a few negative aspects with regard to the use of Einstein Vision® 3D. Only the camera movement lim-itation from the change of perspective and the slightly lower picture detail are disadvantages, otherwise the 3D video provides considerable advantages for lapa-roscopy and thoracoscopy. After a short adaptation phase, particularly if you have been using 2D systems for several years, operating with the Einstein Vision® 3D represents a new era in which the safety and precision of operations has been significantly increased. Einstein Vision® 3D is, in our opinion, the future of laparoscopic and thoracoscopic surgery.

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EXAMPLE OF THE USE OF 3D VIDEO TECHNOLOGY IN RECTAL RESECTION

1. INTRODUCTION

Barmherzigen Brüder Regensburg Hospital is, with 900 beds, the largest Catholic hospital in Germany and the teaching hospital of the University of Regensburg.

The department of general and visceral surgery has 78 beds and performs approximately 3,000 operations per year. The department has a senior physician, a senior proctologist, six attending physicians, five specialists and 12 medical assistants.

With the exception of organ transplants, it performs the full range of general and visceral surgical operations.

Our hospital has been certified by the German Cancer Society as an intestine center, pancreas center and oncology center.

Our hospital has been designated by the German Society for General and Visceral Surgery as a center of excellence for the surgical treatment of pancreases and as a center of excellence for the surgical treatment of malignant peritoneal diseases.

The department is recognized nationally for the treatment of malignant peritoneal diseases. Around 120 operations in peritoneal cancer are performed every year. During these operations, as part of what is known as cytoreductive surgery, multivisceral resection is required in addition to the peritoneal peritonectomy. Following the operation, the abdomen is rinsed with a hyperthermic chemotherapy solution.

Another therapy specialization is colorectal cancer. In the intestine center, we operate on around 100 primary cases with colon cancer and approx. 60 primary cases with rectal cancer every year.

Where possible, modern minimally invasive surgical techniques are used for these operations. So, for example, around 60% of the rectal cancer operations are carried out using minimally invasive techniques.

The department has an MIS theater with fixed integrated 2D video tower and 3 additional permanently installed HD monitors. In addition, there is a portable 2D video tower so laparoscopic operations can be carried out in 2 operating theaters at the same time.

In May 2014, a 3D video tower manufactured by the company Aesculap (Einstein Vision®) was purchased as a third laparoscopy unit. This is also equipped with an HD 2D camera so it can also be used as a fully-fledged laparoscopy unit.

2. USE OF THE 3D VIDEO TECHNOLOGY AT BARMHERZIGEN BRÜDER REGENSBURG HOSPITAL

The 3D tower can be used for all current laparoscopic operations. Due to the improved three-dimensional representation imaging, during routine operations such as a laparoscopic cholecystectomy, TAPP hernia or laparoscopic gastric sleeve, less experienced surgeons in training also benefit from the simplified display of the anatomy thanks to the zoom and accurate representation of anatomical structures. In addition to improved comfort for the surgeon, this may also lead to a reduction in the duration of the operation and prevent mistakes[1,6].

From our point of view, the stereoscopic imaging has the advantage, in complex laparoscopic operations such as distal pancreatectomy[2], gastric resection or laparoscopic Roux-en-Y gastric bypass in particular, of reliable and intuitive spatial orientation with improved depth perception. Even experienced laparoscopic surgeons can benefit from this during such operations[5,6].

After the training required according to the German medical devices act, a surgeon can immediately cope with the new technology so, in our opinion, almost no learning curve is required. Other departments report that it took 5 operations to learn how to handle the technology[3].

In laparoscopic operations that require sutures and intracorporeal knot tying, such as laparoscopic fundoplication, rectopexy, TAPP or gastric resection with anastomotic sutures, the advantages relate, above all, to the three-dimensional orientation in space, above all when maneuvering without a direct spatial reference, for example when aligning the needle during laparoscopic suturing[4].

For a comfortable spatial impression, a minimum distance must be kept between the laparoscope and the object. Therefore, during 3D laparoscopic adhesiolysis in abdominal adhesions, in TEP hernia surgery or transanal minimally invasive surgery (TAMIS), the 3D view is fairly cumbersome. In the event of distorted three dimensional images, it helps to switch to 2D mode occasionally or to operate primarily in 2D[1].

The use of the 3D video tower is described below in rectal resection by way of example.

3. RECTAL RESECTION IN GENERAL

Following comprehensive TME in rectal resection, the prognosis of rectal carcinoma improves dramatically. The local relapse rate can be significantly reduced by the complete removal of the surrounding fatty tissue with intact mesorectum[10]. Thanks to the now anatomically correct dissection, there is now also lower blood loss, and maintenance of the autonomic nerves leads to a better functional outcome in terms of bladder and sexual function[8,9].

With increasing use and experience of MIS, it was soon widely used in the surgical treatment of colorectal carcinoma[11]. In addition to the cosmetic effect, other advantages of MIS include lower use of pain medication, earlier bowel function, and shorter hospitalization with quicker post-operative recovery.

For colon cancer, an equivalent oncological standard with regard to radicality and long-term survival was quickly demonstrated[12].

The evaluation of laparoscopic rectal resection in terms of radicality and long-term survival is still controversial. The data from the Color II study published to date demonstrate, at least, equivalence between MIS in rectal cancer in terms of radicality and long-term survival[13].

According to the current German S3 guidelines, colon cancer and rectal cancer can be treated laparoscopically with the same oncological outcome as with open surgical techniques, provided the surgeon has the appropriate expertise and selection is appropriate.

4. THE LAPAROSCOPIC RECTAL RESECTION

As a result of the literature data, patient advantages and patient desires mentioned above, rectal cancer is increasingly being operated on laparoscopically in increasing numbers at every anatomical level. At our clinic, the figure is 50%, with a significant upward trend, so that sooner or later the lap. rectal operation will also be a training operation.

The 3D video tower is being used more and more in laparoscopic rectal resection. While in the previous model, the camera head was bulky and heavy and had to be supported by a special supporting arm, the new 3D camera head is significantly easier to manage and

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small and, in terms of size and weight, similar to a conventional 2D camera head so it can now be held by the medical assistant with no problems. We use a 30 degree camera, which allows the perspective to be adjusted electronically 30 degrees down and 30 degrees up.

The patient is placed in a modified lithotomy position with the legs extended along the axis of the torso, the tower with the 3D unit is on the left, at around the same height as the patient's back, the 3D monitor is turned so that the surgeon standing to the right of the patient and the cameraman are looking at the monitor at a right angle. The surgeon and assistant wear special 3D glasses. The surgical nurse stands between the patient's legs and generally looks at the 2D screen that is turned towards her and does not wear the glasses.

Once the skin has been disinfected and sterile drapes positioned, the 3D camera, which is 2 separate cameras and covered and handled with a tube (10 mm diameter), is connected to the disposable visual bearing and is thus sterile packaged. The light conductor is integrated into the system and does not have to be separately delivered.

From our perspective, the system with the sterile optical coating has two separate advantages. The 3D camera has a longer lifespan as the required sterilization procedures are omitted. Secondly, the same camera can be used again in a subsequent operation on the same day without having to perform sterilization procedures so it is not necessary to have several expensive 3D cameras available.

The first trocar is inserted paraumbilically either through minilaparotomy under visual control or using a Veress needle after the usual safety tests have been carried out. The subsequent trocars are then applied at the usual sites (right middle and lower abdomen, lower left abdomen) under visual control. During this process, the camera can be switched electronically to a 30 degrees upwards view. This means that the trocars can be positioned as normal under visual control.

Start the dissection from the right at around the level of the promontory. After making an incision in the visceral peritoneum, a very important surgical step is started, namely the mobilization of the upper mesorectum with display and preservation of the dorsal hypogastric nerves.

The mesorectum is a cylindrical three-dimensional structure that is displayed three-dimensionally with superb depth of field using the 3D camera. This scene-like view enables the relationships to the environment to be shown directly, with the hypogastric nerves also shown more clearly in reference to the mesorectum so that they can be preserved more safely.

The next stage of the operation is the radical transection of the inferior mesenteric artery. For this, the mesosigmoid is further separated from the right from the prerenal fascia (Gerota's fascia) laterally and cranially to the left and, where possible, to the inferior edge of the pancreas and the left ureter displayed. The circumferential dissection of the inferior mesenteric artery takes some getting used to if the 30 degree perspective cannot be rotated mechanically upwards to the right - as is normal in 2D laparoscopy. However, this can be achieved after a quick learning curve. The inferior mesenteric artery can be shown in three dimensions and radically transected between clips. Further cranial preparation and transection of the inferior mesenteric artery between endoclips at the inferior edge of the pancreas.

Completion of the mobilization of the sigmoid colon and descending colon from the lateral side up to the spleen and complete mobilization of the left colic

flexure. For this the lesser sac is opened by surgical removal of the greater omentum from the left transverse colon. Again, the stereoscopic representation helps provide reliable orientation in space between the transverse mesocolon, pancreas and posterior gastric surface.

Dissection in the pelvis minor with completion of the TME. Start presacrally progressing laterally on both sides. In full TME, the dorsal dissection in the pelvic floor in the region where the rectum changes section and rises ventrally is made easier by rotating the camera and switching to a 30 degree upwards view. The three-dimensional depth perception improves the anatomical visualization, which is oriented to the outline of the mesorectum. For TME dissection up to the area where the mesorectum runs circularly. The rectum is removed in the pelvic floor region immediately orally of the sphincter with an endo-GIA.

A minilaparotomy with Pfannenstiel incision, oral removal of the intestine with tying of a counter-pressure plate, repositioning of the intestine and anastomosis through descending colorectostomy side to end or colo-pouch-anal anastomosis. Connecting the pressure plate to the transrectally lowered pin is made easier with 3D view, as is the suturing of the posterior vaginal wall in infiltration and resection.

The operation is completed by attaching a double protective ileostomy to the preoperatively marked site.

5. CONCLUSION

The initial experiences with the 3D laparoscopy tower are positive. It is easy to manage with a very short learning curve. The 3D laparoscopy tower has been integrated into our daily work and is used in both common routine operations as well as complex oncological operations.

The main advantage is the three-dimensional spatial display with improved depth perception. This means that anatomical structures, for example nerves in the lesser pelvis, can be visualized better along their course and with regard to neighboring structures and that some stages of the operation, for example, intracorporeal suturing, are made significantly easier. As a result, both less experienced and more experienced laparoscopic surgeons benefit from this technology.

Our experiences so far in rectal resection with total mesorectal excision were described as an example.

Whether there is an improvement in the quality of the outcome in addition to improved comfort for surgeons should be further investigated in clinical studies.

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