Int J Colorectal Dis (2008) 23:547–550
DOI 10.1007/s00384-007-0427-3

CASE REPORT

NOTES—case report of a unidirectional flexible appendectomy

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Accepted: 7 December 2007 / Published online: 7 February 2008

Abstract
Background Natural orifice transluminal endoscopic surgery (NOTES) refers to a new surgical procedure using flexible endoscopes in the abdominal cavity. With this procedure, access is gained by way of organs which are reached through a natural, already-existing external orifice. The hoped-for advantages associated with this method include the reduction of post-operative wound pain, shorter convalescence, avoidance of wound infection and abdominal-wall hernias as well as the absence of scars. We performed a trans-vaginal appendectomy on a human subject.
Materials and methods In experimental operations on animals, we first evaluated the trans-vaginal access site. After them, we started first operation in human. The procedure was carried out under preventive administration of antibiotics. We used a therapeutic single-canal gastroscope. The appendix was located after exploration of the abdomen. After preparation of the mesenteriolum, ligature of the appendix base was performed by means of endoloop, followed by transsection with scissors. Recovery of the specimen was achieved by pulling it out with the instrument.
Results On the evening of the day on which surgery had taken place, administration of nourishment was begun. After the procedure, the patient reported slight soreness in the muscles of the abdominal wall; she felt otherwise perfectly well.
Interpretation In the space of a year, the first operations have been performed on human subjects by a few select work groups. NOTES procedures are still in the initial stages of clinical development. Until they can be introduced into surgical daily routine, further improvements are required as to equipment, technology and operative procedure.

Keywords NOTES · Scarless surgery · Endoscopic appendectomy

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Introduction

Since the first reports of access to the abdominal cavity by means of an external orifice and through an internal organ [1], natural orifice transluminal endoscopic surgery (NOTES) has been developed further in animal experiments

as a new surgical procedure using flexible endoscopes in the abdominal cavity. As the transition from open to laparoscopic surgery has been associated with a marked reduction in the degree of invasiveness, endoscopic transluminal surgery would represent the next step in this cascade; with this procedure, an incision in the abdominal wall is rendered unnecessary [2]. The hoped-for advantages include the reduction of wound pain, shorter convalescence, avoidance of wound infection and abdominal-wall hernias, as well as the absence of scars [3–5]. Access is provided by organs which can be reached by means of a natural external orifice. In animal experiments, access by way of the stomach, the recto-sigmoid, the vagina and the urinary bladder have thus far been described [3, 6, 7]. Possible surgical indications which have already been applied to the animal model are peritoneoscopies, cholecystectomies, appendectomies, tubal ligation, oophorectomies, hysterectomies, hernia repair, as well as gastro-jejunostomies [8–10].

Materials and methods

After completion of experimental operations on animals and evaluation of trans-gastric, trans-colic and trans-vaginal access, we performed the first trans-vaginal appendectomy on a human subject in September 2007. The 28-year-old patient had displayed recurring sub-acute attacks of appendicitis. As she was planning a long stay abroad, she presented to us for an appendectomy. The procedure was carried out under endotracheal anaesthesia in dorso-sacral position under preventive administration of antibiotics. We employed a therapeutic single-canal standard gastroscope manufactured by Olympus which had a working canal of 3.7 mm. CO_2 insufflation took place via working canal by means of an adapter through an insufflator commonly used for laparoscopy, manufactured by Storz.

Following the gynecological opening of the posterior vaginal fornix, the endoscope could be introduced into the abdominal cavity. First, the device was directed towards the front of the abdominal wall; there followed a brief period of exploration and orientation inside the abdomen. The tip of the device could then be positioned in the right lower abdomen and the appendix located. This was then luxated outward (Fig. 1) and moved into an optimal position, with the mesenteriolum stretched out. Near the base, a window was then cut in the mesenteriolum by means of coagulation forceps. The mesenteriolum was subsequently electrothermally separated from the base of the appendix, and coagulation of the arteria appendicularis took place (Fig. 2). At one third of the length, trans-section of the mesenteriolum was performed in the direction of the appendix using a specialised needle knife (IT-Nife, manufactured by MTW). Subsequent ligature of the appendix base by means of endoloop (made by Olympus) could then take place (Fig. 3). A second loop was placed approximately 8 mm aboral to the first ligature. The appendix was cut with scissors between the two ligatures (Fig. 4). Recovery of the appendix was achieved by grasping it at the endoloop; extraction was then performed through the endoscope (Fig. 5). For the sake of safety, we conducted final exploration of the abdominal cavity and performed the decompression during withdrawal of the device. The vaginal site of entry was closed by means of single over-and-over sutures.

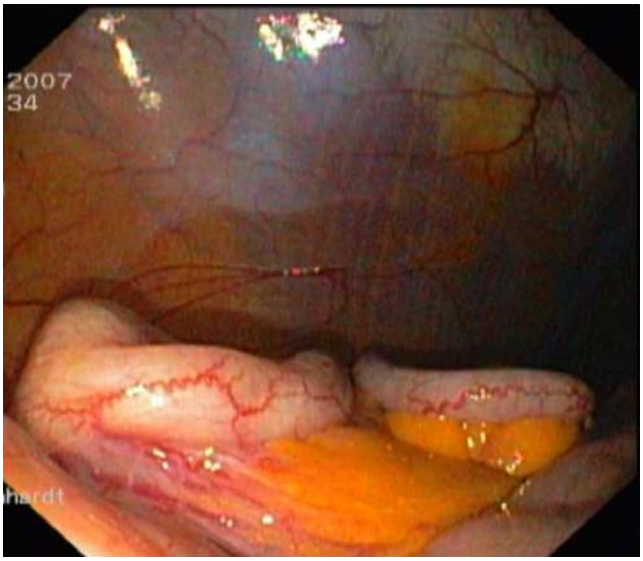

Fig. 1 Outward-luxated appendix

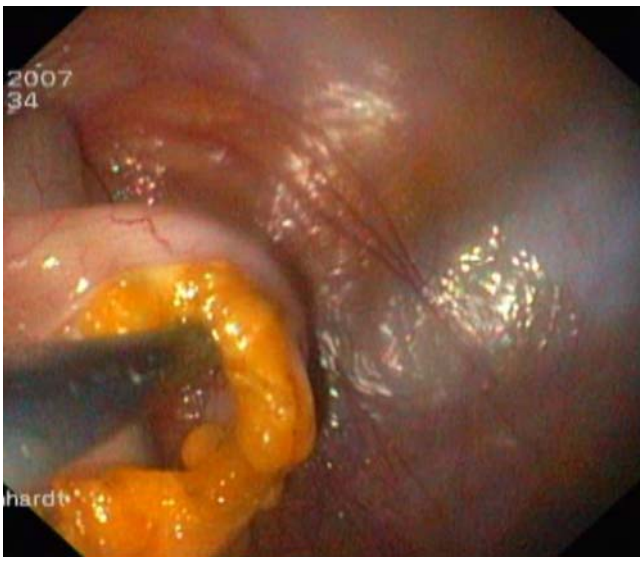

Fig. 2 Electrothermal preparation of the mesenteriolum

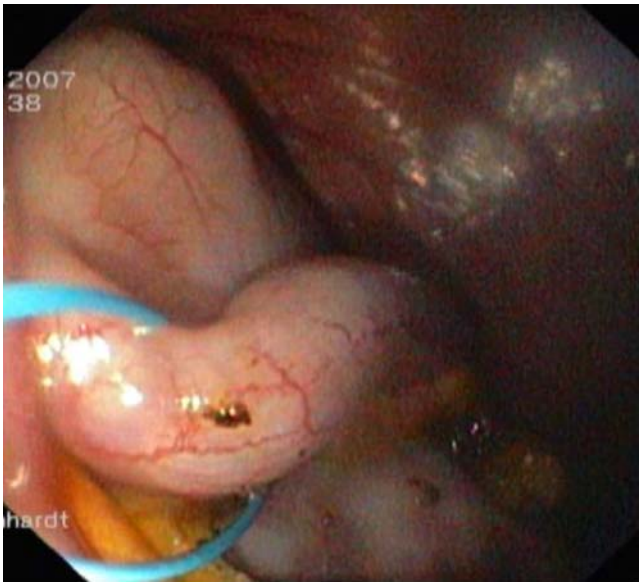

Fig. 3 Endoloop placed near the base

Results

On the evening of the day on which the procedure had taken place, the patient was given her first nourishment. Antibiosis was continued over 3 days. Post-operatively, the patient reported mild muscle soreness in the abdominal wall; she felt otherwise perfectly well. We did not release the patient until the third post-operative day to ensure good quality of post-operative control; on the basis of the patient's subjective state of health, however, her release from hospital could already have taken place on the first post-operative day. The gynecological control after 10 days was unobtrusive. The histological examination of the appendix showed a leukozytic infiltration.

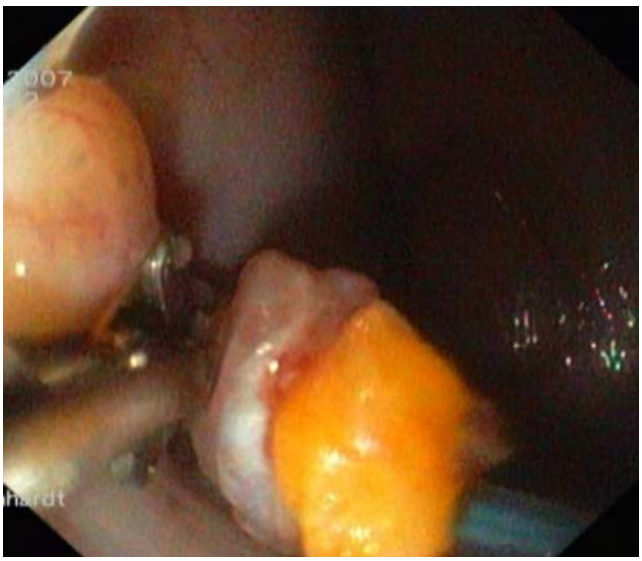

Fig. 4 Cutting between ligatures

Fig. 5 Recovered specimen

Discussion

Within the past year, the first operations have been performed on human subjects in a few select work groups worldwide; these have been primarily hybrid techniques using a trocar in the peri-umbilical region. G.V. Rao presented the first clinical case, his work on the first trans-gastral appendectomy, at the World Congress of Gastroenterology in 2006. Instances of tubal ligation being performed using the same route of access, as well as further appendectomies, followed. It could be demonstrated in animal experiments that, in terms of technical procedure, trans-gastral access can indeed be achieved, especially with the aid of a guide wire introduced via percutaneous gastrotomy needle [11]. Problems which still remain concern the satisfactory closure of the opening created. In other centres, individual cases of trans-vaginal endoscopic cholecystectomy have been performed using the hybrid technique. After transumbilical set-up of a capnoperitoneum, the work group under Marescaux [12] performed the first trans-vaginal cholecystectomy using a double-canal gastroscope. At the Visceral Surgery conference in Germany in 2007, Zornig presented a case of the first trans-vaginal cholecystectomy, which was carried out by means of laparoscopic instruments and hybrid access through the navel. In a blinded prospective study, Hazey et al. [13] compared diagnostic laparoscopy with flexible trans-gastral peritoneoscopy. In nine out of ten cases, there were identical results; this was confirmed in a subsequent open operation.

Our procedure was unidirectional, and hybrid instruments were not used. We chose trans-vaginal access, as this is well-established in gynaecology, and the opening created can be easily closed again. CO_2 insufflation could take place by way of the working canal. The work group under Ponsky demonstrated that the pressure values measured in

the working canal correspond to those in the abdomen [14], which renders separate insufflation via trans-umbilical access superfluous. Unidirectional work did not pose a problem for us; this would, however, not be possible in more complicated procedures.

NOTES procedures still do not represent routine procedure in surgery. Before they can be officially introduced, numerous developments in technology and in the surgical procedure are still necessary. This includes, in particular, operating in more than one direction, development of new flexible instruments, sterilisation and decontamination of endoscopes and access routes as well as the secure endoscopic closure of the internal site of insertion into the abdominal cavity in the case of alternative sites of access.

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