

# Hand-assisted laparoscopic aortic surgery as an initial step toward totally laparoscopic techniques in patients with aorto-iliac occlusion in critical limb ischaemia

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Videosurgery and other miniinvasive techniques 2009; 4 (2): 67–71

## Abstract

**Introduction:** Continuous progress in minimally invasive techniques forces on vascular surgeons the introduction of laparoscopic aortic procedures. Implementation of laparoscopic procedures should reduce invasiveness of procedures while providing comparable outcome with an open procedure.

**Aim:** Assessment of feasibility and of early and mid-term results in patients operated on with hand-assisted laparoscopic technique for aorto-iliac occlusion before introduction of totally laparoscopic aortic repair in everyday practice.

**Material and methods:** Fifteen patients with aorto-iliac occlusion resulting in critical limb ischaemia were qualified randomly for the laparoscopic procedure (median age 53 years, range: 41-64 years). Another 15 patients with comparable disease stage and risk factors and operated on with open procedure were chosen as a control group (median age 58 years, range: 40-73 years). The following parameters were assessed: duration of surgery, aortic clamping time, blood loss, amount of iv fluids administered, time of ICU stay, total postoperative stay, postoperative abdominal pain, 30-day mortality and morbidity, as well as 1-year mortality and morbidity.

**Results:** All patients survived the 30-day postoperative period. No difference in complication rate was observed. Median time of the open procedure (136 minutes) was significantly shorter ( $p < 0.01$ ) than the laparoscopic one (median 190 minutes). No difference in aortic clamping time was observed. Perioperative blood loss between the groups was comparable with median of 350 ml (130-600 ml). Median ICU stay after laparoscopy was 21 hours (range: 16-48 hours) and was significantly shorter ( $p < 0.01$ ) than after an open procedure – median 70 hours (range: 24-56 hours). Patients needed 1500 ml less i.v. fluids during the laparoscopic procedure, but the difference was not statistically significant. Total postoperative hospital stay was 2 days shorter in laparoscopy patients, but the difference was not statistically significant. All patients survived 1-year mid-term follow-up with no difference in outcome among the groups.

**Conclusions:** Hand-assisted procedures give comparable efficacy and safety as open surgery in patients with critical limb ischaemia and aorto-iliac occlusion. Only after sufficient training of aortic dissection in mixed technique can totally laparoscopic aortic procedures be introduced into clinical practice. Shorter stay on ICU and overall shorter hospital stay should stimulate the introduction of vascular aortic laparoscopy. A real benefit can be proven only after introduction of totally laparoscopic procedures.

**Key words:** laparoscopy, aortic surgery, atherosclerosis.

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## Introduction

In 1992 Dion *et al.* successfully tried the first laparoscopic procedure on the abdominal aorta [1]. Despite development of surgical tools and training of a substantial number of surgeons able to perform laparoscopic vascular procedures, laparoscopy remains on the margin of vascular surgery interest. Truly, this is a result as much of the explosive progress in endovascular techniques, which allow even non-surgeons to treat diseases reserved in the past for surgery, as of the reluctance of vascular surgeons to train in the time-consuming technique of laparoscopic suturing and preparation of the aorta. However, constant progress of minimally invasive techniques forces on vascular surgeons the introduction of laparoscopic procedures to routine management in surgery of the abdominal aorta. As complex, specialized tools are needed as much as skills in advanced laparoscopic techniques before totally laparoscopic procedures could be set off, mixed techniques (video-assisted and hand-assisted) should be trained step by step. Increase of the spectrum of laparoscopic operations ought to aim at minimizing invasiveness with equal final effectiveness when compared to classic surgery.

## Aim

Assessment of manageability and early and mid-term postoperative results in patients operated on with hand-assisted technique for occlusion of lower limb arteries in the aorto-iliac region as a step towards implementation of totally laparoscopic procedures into the everyday practice of the department of vascular surgery.

## Material and methods

Informed consent was obtained and 15 patients (median age 53 years, range: 41-64 years) with aorto-iliac arterial occlusion (TASC D lesions) and signs and symptoms of critical lower limb ischaemia according to TASC II definition were qualified for laparoscopic treatment [2]. Fifteen other patients (median age 58 years, range: 40-73 years) with comparable stage of disease and operative risk, treated with open surgery by the very same surgical team, formed the control group. Duration of surgery, aortic clamping time, blood loss, volume of fluids administered during the procedure and on the first

post-op day, length of ICU stay, postoperative hospitalization time, sensation of pain measured on VAS scale and condition of the patient 30 days and 12 months following surgery were assessed. All variables were analyzed statistically with non-parametric tests.

## Open technique

Isolation of the aorta and its bifurcation were accomplished with hand-assisted technique. After an 8 cm long minilaparotomy incision was made in the midline above the umbilicus, the hand-port was introduced. Then in the midline, above the pubic bone a 10 mm trocar for the camera was placed, the peritoneal cavity was inflated and two additional working ports were inserted (Figures 1-4). An assistant held the intestine with his left hand to the right side of the abdominal cavity, opening an access to the aorta, and was able to manoeuvre the camera with his right hand. In laparoscopic technique, the operator isolated the aorta from its bifurcation to the renal arteries. Then, under laparoscopic supervision, retroperitoneal tunnels for prosthetic legs of the aorto-bifemoral graft. After heparin was given, the midline port was temporarily removed, the aorta was cross-clamped and the proximal anastomosis was hand-sewn with additional suture line control from the camera. After the proximal anastomosis was completed, prosthetic legs were stretched into the groin. Distal sutures were applied with the open technique. Following declamping, the abdomen once again was inflated, and haemostasis and suturing of the retroperitoneal space were done using the laparoscopic technique. The operative wound was sutured in layers.

## Results

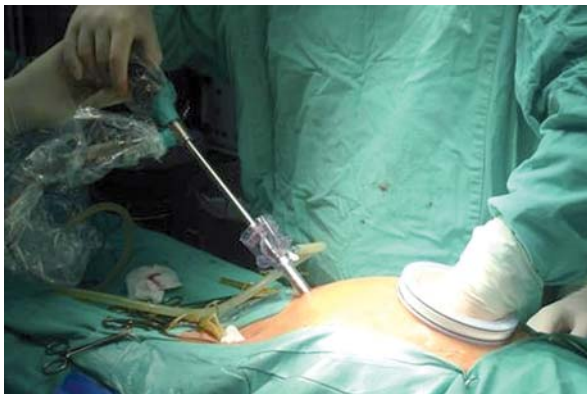
All patients survived the 30-day postoperative period. No difference was seen in severe postoperative complications in 30-day and 12-month follow-up. Duration of the classical procedure (median 136 minutes) was significantly ( $p < 0.05$ ) shorter than the laparoscopic procedure (median 190 minutes). No difference in aortic clamping time was found. Intraoperative blood loss was 350 ml (from 130 to 600 ml) and was identical in both groups. ICU stay was 21 hours (range: 16-48 hours) in the laparoscopy group and was significantly shorter than the 70 hours in the control group (range:



**Figure 1.** Minilaparotomy, trocar introduction, open femoral approach



**Figure 2.** Port introduction, hand is used as retractor



**Figure 3.** Hand-assisted aortic dissection



**Figure 4.** Open proximal anastomosis

24-56 hours). Patients during the laparoscopic procedure required approximately 1500 ml less intravenous fluids, though the difference was not statistically significant. Hospital stay was 2 days shorter after laparoscopic procedures, again with no statistical difference. Less post-operative pain from the incision site was noted in patients operated on with laparoscopy, yet the difference was not significant. Two patients from the laparoscopy group and one in the control group needed re-laparotomy (bowel ischaemia and occlusion ileus due to adhesions in the former group and postoperative haemorrhage in the latter). Complications were not related to laparoscopic technique. All patients survived 12-month follow-up. All patients had a patent vascular prosthesis in clinical and ultrasound examination. No difference in treadmill distance was noted. In two patients from the control group incisional hernia was seen.

## Discussion

Laparoscopy in vascular surgery has to compete with intravascular and robot-assisted procedures [2, 3]. The vascular surgeon, usually with only basic training in laparoscopic surgery, has to perform advanced laparoscopic procedures on the abdominal aorta [4-7]. Parallel progress in endovascular techniques with intra-aortic stent grafts, and stenting of the aorta and iliac arteries, makes selection of the patient for laparoscopic surgery extremely difficult [2, 8]. In our study, we have focused on patients with critical lower limb ischaemia and TASC D-type changes in abdominal arteries. Suturing only one end-to-side vascular anastomosis within the abdominal cavity seems easier for centre beginning with laparoscopic vascular surgery. Hand-assisted technique initially resulted from the lack of a complete tool-set for

totally laparoscopic vascular surgery (vascular clamps in the first place) and from insufficient experience in laparoscopic preparation of the aorta. Not to put patients at increased risk, training was planned according to schedules described in the literature [9-12]. Before the first procedure was performed, theoretical instruction was taken and practical skills were trained in the animal lab in renowned laparoscopic surgery institutions (IRCAD). The training consisted of laparoscopic isolation of the aorta and practising vascular suture [11-13]. Use of video-assisted and hand-assisted techniques did not need change of routines and special training of nurses and anaesthetists. On the other hand, it allowed each and every team member to understand the challenges of laparoscopic technique in vascular surgery. Apart from the benefits derived from decreased ICU stay and relative postoperative pain reduction in the abdominal region, no differences in complication rate or short and mid-term survival were noted. Bowel obstruction and ischaemia, seen in two patients operated on with laparoscopy, were not due to laparoscopic technique, but originated from the open part of the procedure. It must be pointed out however, that hand-assisted technique with open vascular anastomosis does not train the surgeon to perform the most difficult component of the operation, i.e. for laparoscopic vascular anastomosis [11-16]. Due to cautious and longer observation after application of the new technique, we were not able to show a significant reduction of postoperative hospital stay after laparoscopic surgery.

The limited popularity of laparoscopy in vascular surgery is due to the mental barrier rather than true contraindications to such procedures. Lack of mandatory training in vascular laparoscopy during the vascular surgery specialization programme is another obstacle to development. The effectiveness and safety of totally laparoscopic procedures in treatment of diseases of the aorta have been documented in numerous publications [3, 12-14]. Some vascular surgeons erroneously think there is a competition between laparoscopic and intravascular procedures. We believe laparoscopic procedures can substitute for open surgery in patients who cannot be treated with intravascular techniques [4, 12-14]. The similar safety profile, reduced hospital stay, less pain, and smaller cost of ICU stay call for introduction of totally laparoscopic techniques in surgery of the aorta [3-5,

14, 15]. Vascular staplers and pre-fabricated suturing systems for laparoscopy, allowing instant anastomosis of atheromatous arteries and several-fold reduction of vascular anastomosis time, should bring brand new quality [13, 17]. Commercialization of tools for separation of bowels from the surgical field also ought to decrease duration of the procedure and increase its safety [18]. In our opinion, hand-assisted procedures can be a valuable step towards totally laparoscopic surgery of the abdominal aorta; however, real benefits for the patients can be expected only after surgery goes totally laparoscopic. An additional argument for performing laparoscopy in vascular surgery is the opportunity to deal with complications of intravascular treatment of abdominal aortic aneurysms with minimally invasive technique and significant reduction of risk of incisional hernias [19-23].

## Conclusions

Hand-assisted procedures in aorto-iliac occlusion have similar efficacy and safety to open procedures in patients with critical lower limb ischaemia. Once preparation of the aorta has been perfected using combined techniques, totally laparoscopic procedures in surgery of the abdominal aorta can be attempted. Decreased ICU stay and hospitalization time should additionally encourage application of laparoscopy in abdominal aortic surgery. True long-term benefits can be expected with totally laparoscopic surgery of the abdominal aorta.

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