Hand Assisted Laparoscopic Surgery of Aortoiliac Occlusive Disease: Initial Results

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Objectives. Open aortobifemoral bypass grafting has been the procedure of choice for many years in patients with symptomatic aortoiliac occlusive disease (AIOD). Hand assisted laparoscopic surgery (HALS) for AIOD could have advantages like faster recovery, faster oral intake and shorter hospital stay compared to the conventional technique. We documented the results of patients who underwent HALS for AIOD in our hospitals.

Materials and Methods. From January 1999 to December 2002, 33 consecutive patients underwent HALS for AIOD. Peri- and postoperative results were prospectively registered. Three different laparoscopic approaches were applied: transperitoneal, retroperitoneal and apron approach.

Results. There were 23 males and 10 females, with a mean age of 59 years (range 39–85). The surgical technique applied was: transperitoneal: 22 patients, retroperitoneal: 7 patients, apron: 4 patients. Per-operative results (median) of the transperitoneal, retroperitoneal and apron approach are: operating time 240, 420 and 263 minutes, cross clamp time 32.5, 40 and 33.5 minutes, blood loss 1150, 2100 and 950 ml, respectively. Postoperatively oral intake was fully resumed in 3, 4.5 and 2 days after performing the transperitoneal, retroperitoneal and apron technique. During the ICU stay patients received artificial respiration for 0, 1 and 0 days, admission to the ICU was 0.5, 1 and 0.75 days for the transperitoneal, retroperitoneal and apron approach. Finally, hospital stay was 8, 12.5 and 7 days after the transperitoneal, retroperitoneal and apron approach. Four patients (12%) had a minor complication, 4 patients (12%) had a major complication; pneumonia with ARDS, sepsis, bypass occlusion and chylo-abdomen. No patients died.

Conclusions. HALS for AIOD is a technically demanding operation with a long learning curve. All three approaches are feasible. In this series of patients, we feel the transperitoneal and apron approach have the most advantages because of the larger working space. Finally, randomized trials will determine if laparoscopic assisted or total laparoscopic aortoiliac surgery has the potential to reduce morbidity for the patient compared to the conventional technique.

Keywords: Laparoscopy; Aortoiliac; Occlusive.

Introduction

Aortobifemoral bypass grafting has been the procedure of choice in patients with symptomatic or severe aortoiliac occlusive disease (AIOD) providing lesions are not suitable for endoluminal techniques.1 This conventional open procedure is performed through a large longitudinal midline incision. Due to this large incision and extensive bowel manipulation, this procedure is associated with a high incidence of incisional hernia’s and prolonged postoperative ileus. In the last decade, series of laparoscopic aortoiliac surgery for AIOD and aneurysm repair, ranging from hand-assisted laparoscopic surgery (HALS) to totally laparoscopic, have been published.2–10 These studies show promising advantages such as faster recovery, less pain, better pulmonary function and faster oral intake. Three different HALS approaches can be used in treatment of AIOD: transperitoneal, retroperitoneal or apron.11–16 We introduced HALS for AIOD in three hospitals after our vascular surgeons gained experience in specialized centers. All three approaches were applied within our hospitals to gain more experience and to evaluate the feasibility, advantages and disadvantages of each technique.

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Materials and Methods

From January 1999 to December 2002, 33 consecutive patients eligible for HALS of AIOD were included. Informed consent was obtained from the patient prior to surgery when the laparoscopic technique was chosen. Patients qualified for HALS if they were medically fit to undergo laparoscopic surgery and had a lesion unsuitable for endoluminal therapy. Also, the availability of surgical team and operating time were determining factors for performing the laparoscopic technique. Follow up of all patients was the same as conventional treated patients. Digital subtraction angiography or CT-angiography was performed in all patients prior to operation. The surgical approach was chosen at discretion of the vascular surgeon. All of these surgeons had significant expertise in laparoscopic surgery and were trained in the transperitoneal approach. One surgeon was specialized in the retroperitoneal approach and another surgeon in the ‘apron’ approach. All three vascular surgeons operated on the patient as one team. Because planned operation time was 8 hours, operating rooms were infrequently available resulting in limited numbers of laparoscopic surgery for AIOD.

Operating Technique

Retroperitoneal approach (Fig. 1a)

Patients were positioned in a modified right lateral decubitus position. Gel pads were used to aid in the positioning of the patient. The left arm was elevated on an armrest above the head. Access to the retroperitoneum was achieved through a 1.5 cm incision in the left flank, posterior to the anterior axillary line, halfway between the costal margin and the iliac crest. Digital dissection was carried out to the psoas muscle, after which a balloon dissector was inserted. After visualization of the left ureter, the balloon was removed, and a pneumo-retroperitoneum was achieved by

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Fig. 1. Retroperitoneal (a), transperitoneal (b) and apron approach (c). 1. Vertebrae; 2. Kidney; 3. Aorta; 4. Bowel; 5. Peritoneal cavity; 6. Workspace.
Aortoiliac or aortoiliac occlusive disease was managed with aortofemoral bypass grafting through separate groin incisions. A right kidney retraction port and the aortic cross-clamp port were placed in the original left flank incision and was used for the video camera. A handport (Omniport, Weck Closure Systems, Charlote, NC, USA) was attached to the abdominal wall through a 6 cm flank incision with an airtight seal, which enabled the surgeon to use his hand while maintaining the pneumo-retroperitoneum during laparoscopy. Vascular dissection was started at the level of the common iliac artery and both the right and left common iliac arteries were dissected circumferentially. The left kidney was mobilized and held medially with a laparoscopic retractor. The juxtarenal portion of the aorta was then dissected. Right and left groin incisions were performed for femoral anastomosis. Before aortic cross clamping, patients were systemically heparinized. The handport was removed and the incision was used to insert two 2.5 cm blades of a conventional retractor. Using a laparoscopic clamp, the aorta was clamped and with conventional vascular instruments the proximal anastomosis was sutured using a bifurcated woven Dacron graft (Gelsoft, Sulzer-Vascutek USA, INC, Austin, Tex). Next the aortoiliac or aortofemoral bypass grafting was performed through separate groin incisions.

**Apron approach (Fig. 1c)**

Patients were positioned with the left side of the abdomen elevated. Gel pads were used to aid in the positioning of the patient. The operating surgeon was positioned at the right side of the patient. A pneumoperitoneum was established with carbon dioxide to 15 mm Hg through a Veress needle. Through a 1 cm incision at the umbilicus, a 30-degree laparoscopic videocamera (Comeg Endoskopie GmbH) was inserted. A second 10 mm port was placed in the left lower abdomen. Both ports were required for the laparoscopic videocamera. Using a 6 cm incision, a handport (Omniport, Weck Closure Systems, Charlote, NC, USA) was applied in the abdominal wall, which enabled the surgeon to use his hand while maintaining the pneumoperitoneum during laparoscopy. A third 10-mm trocar was placed in the lower abdomen as distal as possible to the other ports. This port was required for the laparoscopic instruments and the suction device. Laparoscopic hand assisted dissection started at the level of the aortic bifurcation. Placing the patient in a 30-degree Trendelenburg position and tilting the table to the right aided the procedure. Both common iliac arteries were dissected. The inferior mesenteric artery was dissected circumferentially and cross-clamped. Dissection was continued proximally up to juxtarenal in the region of the left renal vein and the renal arteries. Digital exploration of the aorta determined the optimal site for clamping and proximal anastomosis. Tunnelling was performed in both groins under digital control and direct vision of the video camera. Before aortic cross clamping, patients were systemically heparinized. The handport was removed and the incision was used to insert two 2.5 cm blades of a conventional retractor. Using a laparoscopic clamp, the aorta was clamped and with conventional vascular instruments the proximal anastomosis was sutured using a bifurcated woven Dacron graft (Gelsoft, Sulzer-Vascutek USA, INC, Austin, Tex). After that the aortoiliac or aortofemoral bypass grafting was performed.

**Transperitoneal approach (Fig. 1b)**

Patients were positioned in a supine position. Gel pads were used to aid in the positioning of the patient. The operating surgeon was positioned at the right side of the patient. A pneumoperitoneum was established to 15 mm Hg through a Veress needle. Through a 1 cm incision at the umbilicus, a 30-degree laparoscopic videocamera (Comeg Endoskopie GmbH) was inserted. A second 10 mm port was placed in the left lower abdomen. Both ports were required for the laparoscopic videocamera. Using a 6 cm incision, a handport (Omniport, Weck Closure Systems, Charlote, NC, USA) was applied in the abdominal wall, which enabled the surgeon to use his hand while maintaining the pneumoperitoneum during laparoscopy. A third 10-mm trocar was placed in the lower abdomen as distal as possible to the other ports. This port was required for the laparoscopic instruments and the suction device. Laparoscopic hand assisted dissection started at the level of the aortic bifurcation. Placing the patient in a 30-degree Trendelenburg position and tilting the table to the right aided the procedure. Both common iliac arteries were dissected. The inferior mesenteric artery was dissected circumferentially and cross-clamped. Dissection was continued proximally up to juxtarenal in the region of the left renal vein and the renal arteries. Digital exploration of the aorta determined the optimal site for clamping and proximal anastomosis. Tunnelling was performed in both groins under digital control and direct vision of the video camera. Before aortic cross clamping, patients were systemically heparinized. The handport was removed and the incision was used to insert two 2.5 cm blades of a conventional retractor. Using a laparoscopic clamp, the aorta was clamped and with conventional vascular instruments the proximal anastomosis was sutured using a bifurcated woven Dacron graft (Gelsoft, Sulzer-Vascutek USA, INC, Austin, Tex). After that the aortoiliac or aortofemoral bypass grafting was performed through separate groin incisions.

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Results

Demographics are shown in Table 1. There were 23 males and 10 females, with a mean age of 59 years (range 39–85). Co-morbidity in the patient group included: cardiac disease: 6 patients, hypertension: 9 patients, diabetes mellitus: 7 patients, pulmonary disease: 2 patients, hypercholesterolemia: 4 patients, smoking: 21 patients. ASA classification; ASA I : 12 patients (34%) ASA II: 15 patients (43%) ASA III ; 6 patients (23%). The surgical technique applied was: transperitoneal: 22 patients, retroperitoneal: 7 patients and apron: 4 patients. The number of operations performed in the different hospitals is as follows: Medical Center Rotterdam Zuid: 8, Reinier de Graaf Hospital: 20 and Sint Franciscus Hospital: 5.

Perioperative results are shown in Table 2. Operating time was more extensive in the retroperitoneal group compared to the transperitoneal and apron group. Cross clamp time and ICU stay were comparable between the three groups. In the retroperitoneal group blood loss was higher and hospital stay prolonged.

The overall 30-day mortality rate was zero. The peri-operative and postoperative complications are shown in Table 3. The minor complication rate was 12% (4 patients) and the major complication rate was 12% (4 patients). According to SVS/ISCVS guidelines, there were 3 systemic, 2 local-vascular and 3 local-non vascular complications. The one patient with the pneumonia developed ARDS that required artificial respiration and thus resulted in a prolonged stay on the ICU (39 days). One patient had a wound infection. Another patient had a sepsis, which required a prolonged stay of 49 days. In one patient, thrombosis in one limb of the aortic bypass graft occurred, requiring thrombectomy. A chyloabdomen in one patient healed within 4 months without special therapy. Coagulation of a bleeding of the groin incision was necessary in one patient. One patient had a persistent atrial flutter which caused a prolonged hospital stay of 18 days. During follow up another patient had an incisional hernia at the handport site. An additional patient had a wound infection that healed within 2 weeks with conservative treatment.

In total, three patients (9%) were converted to an open procedure. Two patients were converted because of poor laparoscopic visibility and one patient was converted because of a lesion of the left renal artery.

Table 1. Demographics

<table>
<thead>
<tr>
<th></th>
<th>Transperitoneal</th>
<th>Retroperitoneal</th>
<th>Apron</th>
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<tbody>
<tr>
<td>No. of patients</td>
<td>22 (67%)</td>
<td>7 (21%)</td>
<td>4 (12%)</td>
</tr>
<tr>
<td>Age- median (range)</td>
<td>56 (39–85)</td>
<td>63 (48–64)</td>
<td>64 (55–66)</td>
</tr>
<tr>
<td>Male</td>
<td>15 (46%)</td>
<td>6 (18%)</td>
<td>2 (6%)</td>
</tr>
<tr>
<td>Female</td>
<td>7 (21%)</td>
<td>1 (3%)</td>
<td>2 (6%)</td>
</tr>
<tr>
<td>Cardiac disease</td>
<td>4 (12%)</td>
<td>2 (6%)</td>
<td>0</td>
</tr>
<tr>
<td>Hypertension</td>
<td>7 (21%)</td>
<td>2 (6%)</td>
<td>0</td>
</tr>
<tr>
<td>Diabetes Mellitus</td>
<td>7 (21%)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Pulmonary disease</td>
<td>1 (3%)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Hypercholesterolemia</td>
<td>3 (9%)</td>
<td>0</td>
<td>1 (3%)</td>
</tr>
<tr>
<td>Smoking</td>
<td>13 (39%)</td>
<td>5 (15%)</td>
<td>3 (9%)</td>
</tr>
<tr>
<td>ASA 1</td>
<td>10 (30%)</td>
<td>0</td>
<td>2 (6%)</td>
</tr>
<tr>
<td>ASA 2</td>
<td>8 (24%)</td>
<td>5 (15%)</td>
<td>2 (6%)</td>
</tr>
<tr>
<td>ASA 3</td>
<td>4 (12%)</td>
<td>2 (6%)</td>
<td>0</td>
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</table>

Three approaches for HALS of AIOD have been described in this study: transperitoneal, retroperitoneal and apron. Due to the longer learning curve we decided to perform the proximal anastomosis in an open fashion instead of a total laparoscopic repair. The aim of this study was to investigate if HALS of AIOD is feasible and learnable for vascular surgeons.

Operative times in this study were all longer compared to open repair of AIOD.17 This is mainly a result of the technical demanding nature of this procedure. Also, we feel we can reduce these operative times with completing the learning curve. In the

Discussion

Three approaches for HALS of AIOD have been described in this study: transperitoneal, retroperitoneal and apron. Due to the longer learning curve we decided to perform the proximal anastomosis in an open fashion instead of a total laparoscopic repair. The aim of this study was to investigate if HALS of AIOD is feasible and learnable for vascular surgeons.

Operative times in this study were all longer compared to open repair of AIOD.17 This is mainly a result of the technical demanding nature of this procedure. Also, we feel we can reduce these operative times with completing the learning curve. In the
retroperitoneal approach we experienced increased operative time compared to the transperitoneal procedure probably as result of the reduced working space. The working space in transperitoneal and apron technique is almost similar resulting in comparable operative times.

In our series median blood loss was higher compared to numbers reported for open repair. A longer dissection time together with several excessive bleedings were the main reasons for this difference. Adequate control of a major bleeding in a laparoscopic fashion is more difficult and time demanding compared to the open technique. We believe that in time, reducing the learning curve, more expertise will be gained in rapid dissection and haemorrhage control.

Cross clamping time in HALS is comparable to that of the open technique due to the fact that the anastomosis is performed in an open fashion.\textsuperscript{18} Even in experienced hands, anastomosis time in total laparoscopic surgery for AIOD is almost twice as long.\textsuperscript{17,19} We advise, when introducing laparoscopic techniques for AIOD, HALS should be preferred and proximal anastomosis should be performed in an open fashion through a mini incision until the learning curve has been completed.

Conversion was necessary in 9\% of the cases due to poor visibility or bleeding. This is somewhat higher than reported by other centers.\textsuperscript{19,20} In this small series the learning curve was not yet completed. With more experience the number of conversions will probably be reduced although conversion should not be defined as a complication but an essential decision in avoiding complications.

Regarding the postoperative complications there was one patient with an incisional hernia. Creating a larger incision for the use of the hand-port and open anastomosis can be related to a higher incidence of incisional hernias.\textsuperscript{21} Total laparoscopic repair avoids this complication. One patient had an ARDS, this could be due to the extensive operative time, which was 420 minutes in the retroperitoneal approach. One patient had an ongoing sepsis from an unknown origin. We ruled out pneumonia, urogenital tract infection, graft infection and an ischemic colon. Another patient had a chylo-abdomen that healed after four months. It is likely that dissection of the aorta caused a lesion of the abdominal cys
terna chyli.

The opinion of our vascular surgeons in this series of patients is that advantages of the transperitoneal and apron approach are a larger workspace and the ability to inspect the abdominal cavity at the end of the operation. In the apron approach it is easier to re
tract intra-abdominal and retroperitoneal structures and have peritoneal isolation of the entire graft at the end of the procedure. An advantage of the retroperitoneal approach is the extraperitoneal route that leaves the peritoneum sac undamaged, so intestines will not be in the field of vision and bowel manipulation is minimal. This approach is preferable in hostile abdomens after multiple abdominal operations.

Disadvantage of the transperitoneal approach is poor visibility because occasionally the retractors cannot grasp intestines in the proper position, increasing operative time. Another possible disadvantage we encounter in the transperitoneal approach is the impossibility to close the retroperitoneum over the prosthesis. A drawback of the apron approach is frequently tearing of the parietal peritoneum during dissection, often requiring change to a transperitoneal approach. The main difficulty of the retroperitoneal approach is the limited workspace, which contributes to extensive operative times. Also tearing of the peritoneum diminishes laparoscopic view. After considering

### Table 2. Perioperative results

<table>
<thead>
<tr>
<th></th>
<th>Transperitoneal (n = 22)</th>
<th>Retroperitoneal (n = 7)</th>
<th>Apron (n = 4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length of operation (min)</td>
<td>240 (185–390)</td>
<td>420 (380–420)</td>
<td>263 (227–270)</td>
</tr>
<tr>
<td>Cross-clamp time (min)</td>
<td>32.5 (15–67)</td>
<td>40 (25–90)</td>
<td>33.5 (22–45)</td>
</tr>
<tr>
<td>ICU stay (days)</td>
<td>0.5 (0.5–1.5)</td>
<td>1 (0.5–39)</td>
<td>0.75 (0.5–1)</td>
</tr>
<tr>
<td>Artificial Respiration</td>
<td>0 (0–1)</td>
<td>1 (0–1)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Oral intake postoperatively (days)</td>
<td>3 (2–5)</td>
<td>4.5 (2–21)</td>
<td>2 (2–3)</td>
</tr>
<tr>
<td>Blood loss (ml)</td>
<td>1150 (150–6500)</td>
<td>2100 (1200–4000)</td>
<td>950 (400–1500)</td>
</tr>
<tr>
<td>Hospital stay (days)</td>
<td>8 (5–18)</td>
<td>12.5 (4–53)</td>
<td>7 (6–7)</td>
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</table>
our results, we think that the transperitoneal approach has the most advantages. However we started with a new approach in 2004 as described by Coggia et al.19,22 This approach is a combined retro-transperitoneal approach. Without the use of intestinal retractors, there are almost no bowels in the laparoscopic view because of the extreme lateral tilt of the patient. An extra advantage is the complete view of the posterior aorta, which makes it easier to control back bleeding of lumbar arteries. Till now we have not witnessed any of the disadvantages as in the before mentioned approaches.

When introducing a new minimally invasive technique for AIOD, hand-assisted surgery can be a good intermediate or definitive step in performing this challenging technique. HALS provides the surgeon with better tactile feedback and can familiarize the surgeon with the laparoscopic approach while still being able to manually handle tissues and control bleedings. After sufficient experience is acquired a switch to total laparoscopic repair can be made at the discretion of the vascular surgeon.

Our aim is to start a randomized control trial that compares the total laparoscopic repair as described by Coggia et al. to the conventional open approach. Our belief is that there is a future for (total) laparoscopic repair in vascular surgery.

References