Analysis of laparoscopic radical nephrectomy for renal cell carcinoma patients with end stage kidney disease requiring hemodialysis

Abstract Introduction and objectives: To examine the safety and feasibility of laparoscopic radical nephrectomy in ESRD patients requiring hemodialysis with renal cell carcinoma.

Materials and methods: One hundred and seventeen HD patients who underwent radical nephrectomy for renal cell carcinoma were the subjects of this study. One hundred and thirty nine laparoscopic radical nephrectomies were performed on 95 patients with unilateral RCC and 22 patients with bilateral RCC.

Results: The transperitoneal and retroperitoneal approaches were selected in 10 (7%) and 129 (93%), respectively. Eleven of 139 cases (8%) had perioperative and postoperative complications including A-V thrombotic occlusion in 2, intestinal damage in 2, local recurrence at removed kidney site in 2 and acute myocardial infarction, leakage of lympho fluid, hypercarcemia, angiocholitis, and pancreatitis each in 1. Ten cases (7%) were converted to open surgery.

Conclusions: HD patients sometimes suffer unex-
pected complications as they often present with multiple comorbidities. It is necessary to examine these patients closely during the perioperative period.

Key words: carcinoma, renal cell, nephrectomy, end-stage kidney disease

Introduction

Patients with end-stage renal disease (ESRD) requiring hemodialysis (HD) have a higher incidence of renal cell carcinoma (RCC) than the general population. Several factors are thought to contribute to this higher risk, including depressed host immunity, impaired antioxidant defense mechanisms, increased synthesis of reactive oxygen species and acquired renal cystic formation. On the other hand, RCCs associated with ESRD are characterized by young patients, predominantly male, are frequently multicentric and bilateral, and less aggressive compared with sporadic RCC. Although patients with ESRD are considered to be high risk candidates for surgery as they often present with multiple comorbidities, they sometimes undergo surgical treatment for early stage RCC. Because of its minimally invasive nature, laparoscopic radical nephrectomy (LPN) has been shown to be a suitable treatment modality for an expanding spectrum of high risk patients. We sometimes encountered adhesive tissue around the kidney and enlarged acquired cystic kidney in HD patients during surgery.

In the present study, we reviewed the complications of laparoscopic radical nephrectomy in HD patients and analyzed the risk factor for surgical complications.

Patients and methods

Patients

Between January 2001 and May 2010, 156 RCC patients treated with ESRD and requiring HD underwent radical nephrectomy in our hospital. Of these, 117...
patients who underwent laparoscopic radical nephrectomy were the subjects of this study. One hundred and thirty nine laparoscopic radical nephrectomies were performed on 95 patients with unilateral RCC and 22 patients with bilateral RCC. The tumors were classified according to the 1997 UICC/AJCC consensus and the WHO (2004) classification systems. Tumor size is defined as the diameter of the largest tumor if there are multiple cancerous lesions in the same kidney. With regard to the evaluation of the tumor stage, the 1997 TNM classification was used.

**Surgical treatment**

All patients underwent hemodialysis one day before surgery. The patient was placed in the lateral decubitus position with the table flat. A pad 20cm in diameter was placed between subcostal area and the table in case of retroperitoneal approach. For the retroperitoneal approach, a 1.5cm incision was made in the middle axillary line 2 cm above the iliac crest. After blunt finger dissection was performed between the psoas fascia posteriorly and the peritoneum anteriorly, a dilator was inserted into the dissected space and inflated with air. The second puncture point was at the junction of the lower costal margin below the 12th rib and the lateral border of the muscle sacrospinalis. The third port was placed at the intersection of the anterior axillary line and an extension line of the first and second port. The fourth port was located at the intersection of the anterior axillary line and subcostal margin of the 12th rib. For the transperitoneal approach, the first port was placed at the inner edge of the rectus abdominis and 3 cm beyond the umbilicus. The second port was located 4.5cm beyond the first port. The third port was located at the intersection of the anterior axillary line and the subcostal margin of the 12th rib. The fourth port was placed at the outer edge of the rectus abdominis and 4.5cm below the first port. A four-port laparoscopic technique was used unless other considerations were involved. Both the renal artery and vein were ligated by Endo-GIA™ 30-2.0 (COVIDEN Japan, Tokyo, Japan) stapler. At the completion of the procedure for all patients, the kidney was placed within the ENDO CATCH™ II (COVIDEN JAPAN, Tokyo, Japan) and removed through the 12-mm port. All patients were transferred to the intensive care unit after surgery. Initial postoperative hemodialysis in the immediate 48 hours after surgery was performed without using heparin.

**Statistical analysis**

All the statistical analyses were performed using the JMP 8.0.1 software (SAS Institute, Cary, NC). Quantitative parameters were compared using the unpaired two-sample t-test, and qualitative parameters were compared using Fisher’s exact test. P values of less than 0.05 were considered to indicate statistical significance. Demographic and clinicopathological parameters were evaluated using a Cox proportional hazards model to determine the variables that were independently correlated with incidence of complications and conversion to open surgery.

**Results**

Patient characteristics are shown in Table 1. The transperitoneal and retroperitoneal approaches were selected in 10 (7%) and 129 (93%) cases respectively. Eleven of 139 cases (8%) had perioperative and postoperative complications. Ten cases (7%) were converted to open surgery for several reasons including uncontrollable hemorrhage in 1, intestinal damage in 2 and difficulty stripping adhesive tissue around the kidney in 7. Table 2 shows details of the complications. Two patients had A-V thrombotic occlusion of an AV

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Patient characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patients</td>
<td>117 patients and 139 kidneys</td>
</tr>
<tr>
<td>Age (yr)</td>
<td>Mean ± SD 57.9 ± 10.3, Median (range) 59 (27–78)</td>
</tr>
<tr>
<td>Gender</td>
<td>Male 110 (80), Female 29 (20)</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>Mean ± SD 21.8 ± 2.61, Median (range) 21.6 (16.4–32.2)</td>
</tr>
<tr>
<td>Preoperative duration of HD (months)</td>
<td>Mean ± SD 185 ± 97.7, Median (range) 180 (8–384)</td>
</tr>
<tr>
<td>Tumor size (mm)</td>
<td>Mea ± SD 34.1 ± 20.4, Median (range) 30 (6–150)</td>
</tr>
<tr>
<td>Approach</td>
<td>Transperitoneum 10 (7%), Retroperitoneum 129 (93%)</td>
</tr>
<tr>
<td>Kidney weight (g)</td>
<td>Mean ± SD 406 ± 298, Median (range) 330 (52–2200)</td>
</tr>
<tr>
<td>Operation time (minutes)</td>
<td>Mean ± SD 249 ± 82.4, Median (range) 249 (102–573)</td>
</tr>
<tr>
<td>Estimated blood loss (ml)</td>
<td>Mea ± SD 141 ± 402, Median (range) 30 (0–4320)</td>
</tr>
<tr>
<td>Complications</td>
<td>Yes 11 (8%), No 128 (92%)</td>
</tr>
<tr>
<td>Conversion to open surgery</td>
<td>Yes 10 (7%), No 129 (93%)</td>
</tr>
<tr>
<td>Pathological stage</td>
<td>stage I 118 (85%), stage II 7 (5%), stage III 7 (5%), stage IV 7 (3%)</td>
</tr>
</tbody>
</table>
fistula during surgery which was repaired during their hospital stay. Two patients sustained damage to their intestines including the duodenum and ascending colon which were repaired perioperatively with conversion to open surgery. Although patient 5 had acute myocardial infarction on the 3rd postoperative day, he received peri-

Table 2 Details of complications

<table>
<thead>
<tr>
<th>Complications</th>
<th>Laterality</th>
<th>Age (yr)</th>
<th>Gender</th>
<th>BMI</th>
<th>Kidney weight (g)</th>
<th>Approach</th>
<th>Operation time (minutes)</th>
<th>Estimate blood loss (ml)</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient 1 Thrombotic occlusion of AV fistula</td>
<td>Right</td>
<td>27</td>
<td>M</td>
<td>21.35</td>
<td>390</td>
<td>Retropertoneum</td>
<td>266</td>
<td>485</td>
<td>Repair</td>
</tr>
<tr>
<td>Patient 2 Thrombotic occlusion of AV fistula</td>
<td>Right</td>
<td>52</td>
<td>M</td>
<td>22.23</td>
<td>590</td>
<td>Retropertoneum</td>
<td>272</td>
<td>30</td>
<td>Repair</td>
</tr>
<tr>
<td>Patient 3 Duodenum damage</td>
<td>Right</td>
<td>55</td>
<td>M</td>
<td>24.5</td>
<td>1300</td>
<td>Retropertoneum</td>
<td>279</td>
<td>370</td>
<td>Conversion to open surgery and repair</td>
</tr>
<tr>
<td>Patient 4 Colon damage</td>
<td>Left</td>
<td>61</td>
<td>M</td>
<td>20.28</td>
<td>365</td>
<td>Retropertoneum</td>
<td>240</td>
<td>250</td>
<td>Conversion to open surgery and repair</td>
</tr>
<tr>
<td>Patient 5 AMI on POD 3</td>
<td>Left</td>
<td>75</td>
<td>M</td>
<td>20.89</td>
<td>330</td>
<td>Retropertoneum</td>
<td>150</td>
<td>30</td>
<td>PCI</td>
</tr>
<tr>
<td>Patient 6 Hyperkalemia</td>
<td>Left</td>
<td>43</td>
<td>M</td>
<td>22.33</td>
<td>210</td>
<td>Retropertoneum</td>
<td>205</td>
<td>20</td>
<td>Emergent HD</td>
</tr>
<tr>
<td>Patient 7 Leakage of lympho fluid</td>
<td>Left</td>
<td>67</td>
<td>M</td>
<td>18.3</td>
<td>450</td>
<td>Retropertoneum</td>
<td>248</td>
<td>100</td>
<td>Natural recovery</td>
</tr>
<tr>
<td>Patient 8 Acute pancreatitis</td>
<td>Right</td>
<td>57</td>
<td>M</td>
<td>21.15</td>
<td>250</td>
<td>Retropertoneum</td>
<td>284</td>
<td>140</td>
<td>Dead on POD 22</td>
</tr>
<tr>
<td>Patient 9 Gastroduodenal artery damage</td>
<td>Right</td>
<td>73</td>
<td>M</td>
<td>22.7</td>
<td>460</td>
<td>Retropertoneum</td>
<td>427</td>
<td>4320</td>
<td>Conversion to open surgery and repair, Dead on POD 46 due to angiocholitis derived from biliary stone</td>
</tr>
<tr>
<td>Patient 10 Local recurrence</td>
<td>Left</td>
<td>59</td>
<td>M</td>
<td>21.6</td>
<td>640</td>
<td>Retropertoneum</td>
<td>353</td>
<td>55</td>
<td>Resection of recurrence tumor</td>
</tr>
<tr>
<td>Patient 11 Local recurrence</td>
<td>Left</td>
<td>56</td>
<td>M</td>
<td>19.7</td>
<td>430</td>
<td>Retropertoneum</td>
<td>275</td>
<td>5</td>
<td>Resection of recurrence tumor</td>
</tr>
</tbody>
</table>

Table 3 Analysis of risk factors for complications

<table>
<thead>
<tr>
<th>Comlications</th>
<th>Yes (N)</th>
<th>No (N)</th>
<th>Total (N)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patients (%)</td>
<td>11 (8%)</td>
<td>128 (92%)</td>
<td>139</td>
<td>0.7306</td>
</tr>
<tr>
<td>Age (yr)</td>
<td>Mean ± SD</td>
<td>56.8 ± 13.5</td>
<td>57.9 ± 10.0</td>
<td>57.9 ± 10.3</td>
</tr>
<tr>
<td></td>
<td>Median (range)</td>
<td>59 (29–78)</td>
<td>57 (27–75)</td>
<td>59 (27–78)</td>
</tr>
<tr>
<td>Gender</td>
<td>Mela</td>
<td>11 (100%)</td>
<td>99 (77%)</td>
<td>110 (80%)</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>0 (0%)</td>
<td>29 (23%)</td>
<td>29 (20%)</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>Mean ± SD</td>
<td>21.4 ± 1.64</td>
<td>21.9 ± 2.68</td>
<td>21.8 ± 2.61</td>
</tr>
<tr>
<td></td>
<td>Median (range)</td>
<td>21.4 (18.3–24.5)</td>
<td>21.7 (16.4–32.3)</td>
<td>21.6 (16.4–32.2)</td>
</tr>
<tr>
<td>Preoperative duration of HD</td>
<td>Mean ± SD</td>
<td>203 ± 104</td>
<td>185 ± 98.8</td>
<td>180 ± 97</td>
</tr>
<tr>
<td></td>
<td>Median (range)</td>
<td>231 (42–355)</td>
<td>177 (71–385)</td>
<td>175 (71–385)</td>
</tr>
<tr>
<td>Kidney weight (g)</td>
<td>Mean ± SD</td>
<td>492 ± 297</td>
<td>396 ± 296</td>
<td>490 ± 296</td>
</tr>
<tr>
<td></td>
<td>Median (range)</td>
<td>430 (210–1300)</td>
<td>322 (52–2200)</td>
<td>345 (152–2200)</td>
</tr>
</tbody>
</table>
Table 4  Analysis of risk factors for conversion to open surgery

<table>
<thead>
<tr>
<th>Conversion</th>
<th>Yes</th>
<th>No</th>
<th>Total</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patients (%)</td>
<td>10 (7%)</td>
<td>129 (93%)</td>
<td>139</td>
<td>0.1164</td>
</tr>
<tr>
<td>Age (yr)</td>
<td>Mean ± SD</td>
<td>62.9 ± 7.5</td>
<td>57.6 ± 10.5</td>
<td>57.9 ± 10.3</td>
</tr>
<tr>
<td></td>
<td>Median (range)</td>
<td>60 (55-75)</td>
<td>59 (27-78)</td>
<td>59 (27-78)</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
<td>0.6877</td>
</tr>
<tr>
<td>Male</td>
<td>9 (90%)</td>
<td>101 (78)</td>
<td>110 (80)</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>1 (10%)</td>
<td>28 (22)</td>
<td>29 (20)</td>
<td></td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>Mean ± SD</td>
<td>23.3 ± 3.7</td>
<td>21.7 ± 2.49</td>
<td>21.8 ± 2.61</td>
</tr>
<tr>
<td></td>
<td>Median (range)</td>
<td>22.9 (18.1-32.3)</td>
<td>21.4 (16.4-28.4)</td>
<td>21.6 (16.4-32.2)</td>
</tr>
<tr>
<td>Preoperative duration of HD (months)</td>
<td>Mean ± SD</td>
<td>239 ±105</td>
<td>181 ±96.3</td>
<td>180 ±97</td>
</tr>
<tr>
<td></td>
<td>Median (range)</td>
<td>262 (91-375)</td>
<td>175 (83-385)</td>
<td>175 (71-385)</td>
</tr>
<tr>
<td>Kidney weight (g)</td>
<td>Mean ± SD</td>
<td>732 ± 646</td>
<td>379 ± 238</td>
<td>490 ± 469</td>
</tr>
<tr>
<td></td>
<td>Median (range)</td>
<td>395 (270-2200)</td>
<td>325 (52-1170)</td>
<td>345 (52-2200)</td>
</tr>
</tbody>
</table>

Cutaneous coronary angioplasty and recovered. Patient 6 suffered uncontrollable hyperkalemia after surgery and underwent emergency HD. Patient 7 suffered persistent leakage of lympho fluid from the drainage tube which recovered naturally. Patient 8 suffered chronic pancreatitis and was prescribed gabexatemesilate before surgery. The level of serum amylase and lipase elevated to 1774 IU/l and 2506 IU/l respectively on the 1st post operative day and CT findings showed inflammatory change at the pancreas tail. He was diagnosed with acute pancreatitis. Although the pancreatitis was improved, angiocholitis appeared due to a bilary stone on the 16th postoperative day. Eventually, he died from sepsis despite being treated in intensive care on the 22nd postoperative day. Perioperative iatrogenic damage for pancreas was not revealed by recorded film, so the cause of pancreatitis was thought to have been induced by anesthesia or drugs. Patient 9 sustained damage to the gastro-duodenal artery which was repaired by open surgery. He suffered persistent angiocholitis derived from a bilary stone despite of percutaneous transhepaticcholangio drainage and died of a sepsis on the 46th postoperative day. Patient 10 was pointed out a tumor 27 mm in diameter at retro-peritoneal space 29 month after radical nephrectomy. The tumor was resected with recurrence of renal cell carcinoma. Patient 11 also diagnosed with recurrence of RCC 36 months after surgery. Table 3 shows the analysis of risk factors for complications. None of the factors including age, gender, BMI, duration of HD and kidney weight influenced the incidence of complications. Factors for predicting conversion to open surgery are shown on Table 4. Kidney weight had the only significant difference between patients with conversion to open surgery and those without (with conversion : 752 ± 646g (270-2200), without conversion : 379 ± 238 (52-1170), P=0.0001).

Discussion

In the present study, although no patients died from iatrogenic complications, eleven of 139 cases (8%) had perioperative and postoperative complications. The incidence rates are comparable to most series of laparoscopic nephrectomy in patients with non ESRD patients.10 Patients with ESRD were considered to be high risk candidates for surgery because of multiple comorbidity such as diabetes, hypertension, and cardiovascular disease. LPN has been applied for ESRD patients with regard to minimal invasive treatment. In fact, hemorrhage during surgery was low because of insufflation of the abdominal cavity and small wounds. On the other hand, we sometimes encountered postoperative hemorrhage. ESRD is commonly associated with bleeding tendency, mainly because of platelet dysfunction.11 Ahmed et al. reported 3.2% of ESRD patients who underwent laparoscopic nephrectomy had hemorrhagic problems.12 Some reports compared ESRD patients and non-ESRD patients who underwent laparoscopic nephrectomy.13 Although estimated blood loss was not significantly different between the two groups, ESRD patients needed more blood transfusions than non-ESRD patients in the postoperative periods. This was thought to have been induced by preoperative low levels of hemoglobin and anticoagulants during hemodialysis. Bird et al reported that although there was no significant difference in intraoperative and postoperative complications between ESRD and non-ESRD patients, patients with ESRD patients required a longer hospital stay (ESRD : 108 ± 65.9 hours, Non-ESRD : 80.7 ± 42 hours, P=0.0001). They also reported that postoperative complication was significantly associated with age adjusted charlson comorbidity index (P=0.019) and previous abdominal surgery (P=0.006).14

Laparoscopic surgery has some beneficial features compared to open surgery. Desai et al compared opera-
tive feature and complications between open and laparo-
sopic nephrectomy in patients with renal failure attrib-
uted to ADPKD. The hospital stay, analgesic require-
ment and blood transfusion rates were significantly less
with laparoscopy despite the similar specimen weight.
There were two conversions (9%) : one patient had
an inferior vena cava (IVC) tear and the other had
extensive adhesions. In our study, 10 patients (7%) con-
verted to open surgery, which is similar to other
institutes. In our study, 20 % of patients (3/14) with
more than 700g weigh tumor were converted to open
surgery. Although the indication for laparoscopic sur-
gery for localized RCC with ESRD patients has not been
discussed, large tumors which occupied with abdomi-
unal space should be performed with open surgery.

In our institute, both the retroperitoneal and the
transperitoneal approach were properly used according
to history of surgery or kidney size. ESRD patients are
commonly associated with metabolic acidosis that may
be aggravated by CO2 retention, particularly in the ret-
roperitoneal approach. Moreover, they are associated
with an increasing incidence of conversion compared
with the transperitoneal approach for average and large
renal units. We undertook resection of the local recur-
rence at the removed kidney site in the patient with a
ruptured renal cyst at the time of nephrectomy. It was
thought to have been induced by limited retroperitoneal
space. On the other hand, the transperitoneal approach
is difficult in patients with a history of abdominal sur-
gery. The incidence of bowel injury or postoperative
ileus was more common in the transperitoneal approach.
However, Shoma et al reported that both transperitoneal
and retroperitoneal laparoscopic nephrectomy patients
had similar incidences of complications and hospital
stay. After local recurrences were appeared as shown
Table 2, we choose transperitoneal approach to secure
wide surgical field except for patients with history of
abdominal surgery. Although whether the strategy is
correct or not has not been determined, large kidneys
with multiple cysts should be undergone with transperi-
toneal approach.

Conclusions
Laparoscopic nephrectomy in patients with EDRD is
feasible and safe. However, ESRD patients have a high
risk for surgery and we always have to be watchful for
unexpected comorbidity.

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