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Short-term Outcomes of Liver Resection in Patients With Hemodialysis

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Abstract. *Background: The number of patients with hemodialysis is increasing increased yearly. Few reports are available on hepatobiliary and gastrointestinal surgery in these patients. Patients and Methods: A total of 222 patients who underwent partial liver resection or segmentectomy in our hospital between January 2015 and September 2019 were included in this study. Patients were divided into the hemodialysis group (n=9) and non-hemodialysis group (n=213). Results: No significant difference was observed in postoperative complications between the hemodialysis and non-hemodialysis group. The hemodialysis group had a significantly higher infectious complication rates than the non-hemodialysis group (33.3% vs. 8.0%, p=0.009). In logistic regression analysis, hemodialysis was only a significant risk factor for postoperative infectious complications (OR=5.61, 95% CI=1.12-28.20, p=0.036). Conclusion: Liver resections, at least segmentectomy or smaller, is acceptable in patients on hemodialysis. However, these patients may have a higher risk of postoperative infectious complications than other patients.*

The number of patients with end-stage renal disease who depend on maintenance hemodialysis has increased each year. In 2017, the number of patients with hemodialysis in Japan reached almost 330,000 and newly introduced cases reached almost 40,000 (1). The incidence of cancer among dialysis patients has also increased. In some reports, 7.7-46.7 % of hemodialysis patients have been diagnosed with cancer within five years from introducing hemodialysis (2-4).

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Surgery is often selected for cancer in dialysis patients because the efficacy and safety of drug therapy, including molecularly targeted drugs, has not been established for dialysis patients (5). However, there are concerns that they have an increased risk of complications (6). Furthermore, few reports are available on abdominal surgery, especially hepatobiliary and gastrointestinal surgery in these patients (7, 8). Regardless of whether the patients receive hemodialysis or not, liver resection prolongs survival and sometimes provides a cure for patients with liver malignancies (9). If procedures are performed safely, surgery may be a valid choice.

Patients and Methods

A total of 222 patients who underwent partial liver resection or segmentectomy in our hospital between January 2015 and September 2019 were retrospectively identified and included in this study. The patients were divided into two groups: the hemodialysis group (HD group; *n*=9) and the non-hemodialysis group (non-HD group; *n*=213). Background and perioperative variables were collected from the medical charts. Postoperative complications were defined as those with Clavien-Dindo classification grade ≥III within 30 days after surgery (10).

All statistical analyses were performed with EZR (11), which is a modified version of R Commander. The χ^2 test was performed to compare frequencies between groups. For continuous variables, differences between groups were compared using Student's *t*-test. If values did not show a normal distribution, the Mann-Whitney *U*-test was used. Two-sided *p*-values of <0.05 were considered statistically significant. This retrospective observational study was conducted in accordance with the Declaration of Helsinki, and the study protocol was approved by the Ethics Review Committee of Nippon Medical School.

Results

Nine patients on hemodialysis underwent elective liver resection in our hospital between January 2015 and September 2019. Their characteristics are presented in Table I. The dialysis period ranged from 4 months to 10 years (mean, 3.93±3.03 years). The causes of renal dysfunction

Table I. *Characteristics of patients with hemodialysis.*

Age, years	Gender	Duration of HD, years	Reason for HD	Tumor location	Operation	Pathology	Administration period of Abx, day	Complication	CD	Placement of drainage tube	Bacterial profile	OS, month
60	M	1	DM	S3	Lap/P	HCC	2	-	0	-	-	42(D)
85	F	1	HT	S4a+S5	EC	GBC	3	-	0	Resected area	-	36(A)
74	M	5	HT	S5	Lap/P	HCC	4	-	0	Resected area	-	28(A)
70	M	4	DM	S4	P	HCC	3	-	0	Resected area	-	22(A)
62	M	6	DM	S4a+S5	S	Met	3	-	0	Resected area	-	19(A)
78	M	0.4	HT	S3	Lap/P	HCC	3	-	0	Resected area	-	6(D)
68	F	5	DM	S8	Lap/P	ICC	10	IA	IIIa	Resected area	*E cloacae*	20(A)
77	M	3	DM	S7	S	HCC	4	Pyothorax, IA	IIIa	Resected area, chest	*E fecaelis*	12(A)
71	M	10	DM	S6	Lap/P	HCC	3	IA	IIIa	Resected area	*E cloacae*	8(A)

HD: Hemodialysis; DM: diabetes mellitus; HT: hypertension; Lap: laparoscopic surgery; P: partial liver resection; EC: extended cholecystectomy; S: segmentectomy; HCC: hepatocellular carcinoma; GBC: gallbladder carcinoma; Met: metastatic tumor; ICC: intrahepatic cholangiocarcinoma; Abx: antimicrobial prophylaxis; IA: intraabdominal abscess; CD: Clavien-Dindo; OS: overall survival; E cloacae: Enterobacter cloacae; E fecaelis: Enterococcus fecaelis; D: dead; A: alive.

were diabetic nephropathy (six cases) and nephrosclerosis associated with hypertension (three cases). The performed operation was partial resection in six cases, segmentectomy in two cases, and extended cholecystectomy in one case. Laparoscopic surgery was performed in five cases (55.6%). Although one patient did not detain the drainage tube, the other patients detained the drainage tube at the resected area. Duration of drainage tube placement was between 4 and 7 days and the administration period of antimicrobial prophylaxis was 1 to 10 days after the operation.

Postoperative complications occurred in three patients (33.3%); all were infectious complications, including intraabdominal abscess (three cases) and pyothorax (one case). The location of the tumor in these cases was at the right anterior superior segment called S8, and right posterior inferior and superior segments called S6 and 7. All abdominal abscesses had formed in the resected area and the pyothorax accumulated across the diaphragm from the abdominal abscess. No patient in this group experienced bile leakage because their bilirubin levels of drainage were within the normal range.

Patients with and without hemodialysis are compared in Table II. No life-threatening complications occurred. Although no significant differences in postoperative complications were observed between the HD group and the non-HD group (33.3% *vs.* 14.0%, p=0.26), the infectious complication rate was significantly higher in the HD group compared to the non-HD group (33.3% *vs.* 8.0%, p=0.009). The risk factor for infectious complications in univariate analysis were age, preoperative blood albumin level, intra- and postoperative transfusion of red blood cells, and hemodialysis. Logistic regression analysis of the factors associated with infectious complications is presented in Table III. Only hemodialysis was significantly associated with an increased risk of postoperative infectious complications (OR=5.61, 95% CI=1.12-28.20, p=0.036).

Discussion

The number of patients with end-stage renal disease (ESRD) who depend on maintenance hemodialysis and have increased yearly. The incidence of cancer among those patients has also increased. There are reports that patients with hemodialysis who undergo surgery have high morbidity and mortality rates due to the difficulty of controlling body fluids, tendency to bleed, compromised status and delayed wound healing (6, 8, 12). The patients on hemodialysis are in an immunosuppressive state because their acquired immunity is impaired and T-cell numbers decrease (6, 13). Furthermore, ascites and pleural effusion, which can predispose to infection, tend to accumulate (14). Thus, the accumulation of ascites in the closed space may have triggered abscess formation. In two of the three cases where complications were experienced, the resection site was facing the diaphragm, while ascites and blood accumulated between the diaphragm and liver, which may have been the site of the infection.

It is considered that liver resection for patients with ESRD may be performed safely with thorough intra- and postoperative management. Shirata *et al.* (15) reported that liver resection for Child-Pugh A patients with ESRD is safe and has comparable oncological outcomes compared to non-ESRD patients. However, liver resection in patients with hemodialysis is considered to have a higher morbidity and mortality rate than those without hemodialysis (16, 17). Shinkawa *et al.* (9) reported that both morbidity and mortality

Table II. *Patient characteristics in the hemodialysis and non-hemodialysis group.*

	HD group (n=9)	Non-HD group (n=213)	*p*-Value
Age, years	71.67±7.89	68.31±11.34	0.383
Gender (M:F)	7:2	148:65	0.871
BMI, kg/m^2	24.07±6.23	23.39±4.39	NS
Diabetes mellitus	6 (66.7%)	60 (28.2%)	0.013
Hypertension	9 (100%)	101 (47.4%)	<0.01
Diagnosis H:M:I:G:O	6:1:1:1:0	83:108:4:5:13	<0.01
Operation time, min	233.00±90.71	272.52±106.58	0.274
Blood loss, ml	296.44±377.88	253.70±355.80	0.725
Transfusion (red blood cells)	1 (11.1%)	20 (9.4%)	0.863
Transfusion (platelets)	1 (11.1%)	7 (3.3%)	0.748
Complications (CD≥3)	3 (33.3%)	30 (14.0%)	0.266
Infectious complications	3 (33.3%)	17 (8.0%)	<0.01
Post operation stay (day)	14.63±12.76	12.0±11.75	0.531
Pre-operative blood test			
T-Bil, mg/dl	0.42±0.21	0.67±0.37	0.047
PLT (10^4/μl)	15.64±6.84	19.68±8.98	0.185
PT (%)	104.53±22.43	95.99±19.62	0.205
ICG-R15 (%)	8.28±3.98	11.51±7.0	0.171
Child-Pugh score (A:B)	9:0	203:10	0.854
Liver damage (A:B)	9:0	183:30	0.476

Values shown are mean±standard deviation, number of patients, or number (percentage). NS: Not significant; BMI: body mass index; H:M:I:G:O: Hepatocellular carcinoma: Metastatic tumor: Intrahepatic cholangiocarcinoma: Gallbladder carcinoma: Others; CD: Clavien-Dindo; T-Bil: total bilirubin; PLT: platelet; PT: prothrombin time; ICG-R15: indocyanine green retention rate at 15 min.

were significantly higher after liver resection among patients with hemodialysis than those without. That study also found no significant difference in mortality between hemodialysis and non-hemodialysis patients who underwent limited liver resection. In our study, it was considered feasible to perform liver resection in hemodialysis patients if it was a smaller operation up to segmentectomy; a view that is consistent with the above report.

Our study has some limitations. First, this was a retrospective, single-center study with a small number of subjects. Second, this study targeted multiple diseases and surgical procedures. In addition, because dialysis patients are considered high risk, these patients may not have chosen surgical treatment or may have had a reduced operation if surgery was performed, and thus selection bias may have been present. Therefore, the results of the present study should be carefully interpreted, and a prospective study with a larger number of patients is required. Liver resection, at least when segmentectomy or a smaller operation is indicated, can be acceptable in patients with hemodialysis, as no life-threatening complications occur in those. However, we should pay close attention to postoperative infectious complications in this population. Particular attention may be needed for liver resection of the area facing the diaphragm, as fluid may easily accumulate in the surgical site.

Table III. *Multivariate analysis of postoperative infectious complications.*

	Odds ratio	95% CI	*p*-Value
Age	1.03	0.97-1.10	0.42
Hemodialysis	5.61	1.12-28.20	0.036
Transfusion (RBC)	2.26	0.61-8.39	0.22
Alb (preoperative)	0.375	0.14-1.04	0.059

RBC: Red blood cells; Alb: albumin.

Conflicts of Interest

Shintaro Kanaka, Yuto Aoki, Masato Yoshioka, Youichi Kawano, Tetsuya Shimizu, Tomohiro Kanda, Ryota Kondo, Yohei Kaneya and Hiroshi Yoshida have no conflicts of interest to declare.

Authors' Contributions

All Authors contributed to the study concept and design. Data analysis was conducted by S.K. and Y.A. and was checked by the other authors. The first draft of the manuscript was written by S.K. and all authors commented on the previous version of the manuscript. All Authors read and approved the final manuscript.

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