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Zinc supports liver regeneration after partial resection

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ABSTRACT

Objective: Safe removal of extensive liver tumor burdens depends on regeneration of the remnant liver, which requires a large amount of zinc over a short period of time. We studied how zinc influences regeneration.

Material and Methods: We measured perioperative serum zinc concentrations after liver cancer diagnosis in 77 patients undergoing hepatectomy to determine how serum zinc affected short-term outcomes and remnant liver regeneration.

Results: Serum zinc concentration at diagnosis showed no correlation with inflammatory or nutritional parameters except for a weak correlation with the lymphocyte-to-monocyte ratio. When patients were divided into a high pre-hepatectomy zinc group (≥75 µg/dL, n= 39, H group) and a low zinc group (<75 µg/dL, n= 38, L group), short-term results such as mortality (p> 0.999), morbidity (p= 0.490), and hospital stay (p= 0.591) did not differ between groups. However, hypertrophy in the future liver remnant after hepatectomy in the H group (127.7 ± 24.7% of original volume) was greater than in the L group (115.9 ± 16.7%, p= 0.024). In a subgroup of patients with extended hepatectomy, hypertrophy was 130.9 ± 26.8% in the H group vs. 116.4 ± 16.5% in the L group (p= 0.037).

Conclusion: Greater serum zinc at diagnosis was associated with greater hypertrophy in the future liver remnant.

Keywords: Zinc, hepatectomy, liver regeneration, nutritional parameters, short-term outcome

INTRODUCTION

Safe removal of an extensive liver tumor burden, a principal goal of hepatobiliary surgeons, largely depends on regeneration of the remnant liver after resection. Strong stimulation of hypertrophy in the remnant is indispensable. Multiple variables including the extent of liver resection (1-4), liver function (1,4-7), age (5), and hepatotrophic factors in portal blood (8,9) have been shown to influence liver regeneration after hepatectomy.

After partial hepatectomy, hepatocytes undergo a synchronized sequence of priming/initiation, proliferation, and growth termination. These steps are essential for the restoration of hepatic structure and function. Zinc, the second most prevalent trace element in the body, is essential for normal cell growth, development, and differentiation. A clinical role for zinc in wound healing was initially postulated in treating pilonidal sinuses (10). After investigators then reported depressed wound healing in zinc-deficient compared to zinc-sufficient experimental animals, zinc has taken on an important role in clinical wound healing (11,12). Hepatocyte regeneration after liver resection represents a form of wound healing that requires a large amount of zinc over a short period of time. This demand is partly met by the induction of a zinc and copper binding protein, metallothionein, during a priming phase soon after resection (13). Metallothionein can transfer zinc to various metalloenzymes and transcription factors, while metallothionein knockout mice show impaired liver regeneration (14). Thus, zinc is essential for liver regeneration.

We hypothesized that liver regeneration after partial hepatectomy for an extensive tumor burden could be enhanced by zinc supplementation. As a preliminary step, the present retrospective study examined the effect of pre-hepatectomy serum zinc concentrations on short-term clinical outcomes after hepatectomy and also the possibility of a relationship between serum zinc concentration and postoperative changes in remnant liver volume.

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MATERIAL and METHODS

Patients

We measured perioperative serum zinc concentration in 77 patients who underwent hepatectomy between April 2021 and December 2022 at the Department of General and Gastroenterological Surgery, Showa University Fujigaoka Hospital.

These patients included 47 males and 30 females; their median age was 69 years (range, 49 to 87). Histologic diagnoses in these patients were metastatic carcinoma, typically from a colorectal primary, in 38 (49.4%); hepatocellular carcinoma in 22 (28.6%); cholangiocarcinoma in four (5.2%); and biliary cancer in 10 (13.0%). Three patients had other histologic types of cancer (3.9%). Hepatectomy procedures were partial resection of a segment in 38 patients and resection of one segment or more in 39. Ten of the patients in the latter group were undergoing repeat hepatectomy for remnant liver disease.

In a manner described in a previous report, patients with low to intermediate serum zinc concentrations at time of liver tumor diagnosis were given an opportunity to receive an oral zinc supplement preoperatively (Novelzin, Novel Pharma, Tokyo, Japan) if they and their attending physicians chose (15). Patients' freedom to choose was particularly important because the supplement represented a significant out-of-pocket expense. Daily doses were 50 or 100 mg, based upon serum zinc concentrations at diagnosis.

Relationships Between Serum Zinc and Other Nutritional Parameters

Serum zinc concentrations at the time of diagnosis were examined for association with other inflammatory and nutritional parameters, specifically body mass index (BMI), Onodera prognostic nutritional index (PNI), neutrophil-to-lymphocyte ratio (NLR), platelet-to-lymphocyte ratio (PLR), lymphocyte-to-monocyte ratio (LMR), C-reactive protein-to-albumin ratio (CAR), Glasgow prognostic score (GPS), modified GPS, and controlling nutritional status (CONUT) score (16-19). Parameters were calculated using the following formulas: BMI= body weight (kg)/[height (m)]^2; PNI= 10 × serum albumin (g/dL) + 0.005 × lymphocyte count (/mm^3); NLR= neutrophil count (/mm^3)/lymphocyte count (/mm^3); PLR= platelet count (/mm^3)/lymphocyte count (/mm^3); LMR= lymphocyte count (/mm^3)/monocyte count (/mm^3), and CAR= serum C-reactive protein (mg/dL)/serum albumin (g/dL). GPS, modified GPS, and CONUT scores were obtained according to previous reports (17-19).

Hepatectomy Procedures

The guiding principle of hepatectomy was assurance of tumor-free margins. Acceptability of a hepatectomy procedure for a given patient was determined by a prediction score (PS) system introduced by Yamanaka and the predicted remnant liver indocyanine green (ICG) disappearance rate from plasma (KICG) (20-22). PS was calculated using the formula -84.6 + 0.933 a + 1.11 b + 0.999 c, where a was the resection fraction (%) calculated from computed tomographic (CT) volumetry; b, the ICG retention rate at 15 min; and c, the age of the patient. Remnant KICG (rem KICG) was calculated using the formula, KICG × [estimated future liver remnant (FLR) volume/total estimated liver volume (TELV)]. Both FLR volume and TELV were calculated based on CT volumetry as described in the next paragraph. A PS less than 50 and/or a rem KICG more than 0.05 indicated that a given hepatectomy would be acceptable.

Parenchymal dissection was performed using ultrasonic dissectors during either open or laparoscopic approaches. When necessary, the liver pedicle was clamped intermittently in cycles including 15 min of clamping and five min of reperfusion. The Brisbane 2000 terminology of the International Hepato-Pancreato-Biliary Association was used to designate operative procedures (23).

CT Volumetry

CT was performed with a scanner possessing 64 rows of detectors (Revolution Maxima or Discovery CT 750HD; GE, Fairfield, CT, US). After administering a contrast agent (Iopromide 370; Fujifilm Toyama Chemical, Tokyo, Japan), serial transverse scans were obtained from the dome of the liver to its most inferior extent using the following settings: 100 KV; Max 560 mA-sec (AutomA Noise Index, 10.5); section thickness/collimation, 5/0.625 mm; feed/rotation, 20.62 mm; rotation time, 0.4 sec; and reconstruction increment, 2.5 mm. Areas of interest in each slice of the liver were traced with a cursor, and the corresponding area was calculated by computer. The estimated FLR volume was calculated from data obtained prior to hepatectomy, and TELV was calculated from the data obtained before hepatectomy and one week after hepatectomy. Estimated FLR volume was calculated using the following formula: TELV before hepatectomy (mL)-estimated volume planned to be resected (mL). When a hepatectomy procedure was altered intraoperatively because of newly detected tumor, technical difficulty in carrying out the planned procedure, or other reasons, estimated FLR volume was calculated as follows: TELV before hepatectomy (mL)-actual resected liver volume (mL). The hypertrophy ratio in terms of liver volume corresponding to FLR after hepatectomy was calculated using the formula, [TELV one week after the procedure (mL)/volume of FLR before the procedure (mL)] × 100 (%).

Short-Term Outcome

Postoperative patient outcomes were assessed using hepatectomy-related morbidities, mortality, and duration of hospital stay. Grades of post-hepatectomy liver failure (PHLF) and bile leakage (BL) were based on the criteria of the International Study Group of Liver Surgery (ISGLS) (24,25). Morbidities were assessed according to the Dindo-Clavien classification (26).

Data Analysis

Statistical comparisons of baseline data were performed by the Mann-Whitney U test, the χ^2 test, or Fisher's exact test as appropriate. Correlations between two continuous variables was calculated by Spearman's rank correlation coefficient. A difference was considered significant when p had a value below 0.05.

Ethical Approval and Consent to Participation

The study protocol was approved by the Institutional Ethics Committee of Showa University, Japan (notice of IRB approval of protocol number, 2023-002-A). All patients included in this study provided informed consent for use of anonymous data through an opt-out methodology.

RESULTS

Serial Changes of Serum Zinc

At diagnosis, serum zinc concentration considering all patients (median with range) was 66 μg/dL (24-142). Among the 77 participants, zinc was administered preoperatively to 50. Before hepatectomy, median serum zinc concentration in those 50 patients increased to 75 μg/dL (47-167); p= 0.002 vs. the zinc concentration at diagnosis (Figure 1A). In 27 patients without preoperative administration of zinc, the concentration decreased from 66 μg/dL (44-134) at diagnosis to 60 μg/dL (4-134) before the operation (p= 0.056) (Figure 1B). In the 50 patients with preoperative administration of zinc, serum zinc increased from 65 μg/dL (24-142) to 75 μg/dL (47-167, p< 0.001) (Figure 1C).

Relationships Between Serum Zinc and Other Inflammatory/Nutritional Parameters

Possible relationships between serum zinc at diagnosis and other inflammatory and/or nutritional parameters were analyzed. No relationships were evident between serum zinc at diagnosis and other parameters such as BMI (R= -0.005, p= 0.963), Onodera PNI (R= 0.014, p= 0.902), NLR (R= -0.096, p= 0.407), PLR (R= -0.028, p= 0.809), and CAR (R= -0.022, p= 0.853). Only LMR showed a weak correlation with serum zinc concentration (R= 0.213, p= 0.063) (Figure 2).

Serum zinc concentration (median with range) of patients with a GPS of 0 (n= 65) was 66.0 μg/dL (42-142), while that of patients with GPS of 1 or 2 (n= 12) was 66.5 μg/dL (24-120, p= 0.911). Serum zinc concentration of patients with modified GPS of 0 was 65.0 μg/dL (42-134), while that of patients with modified

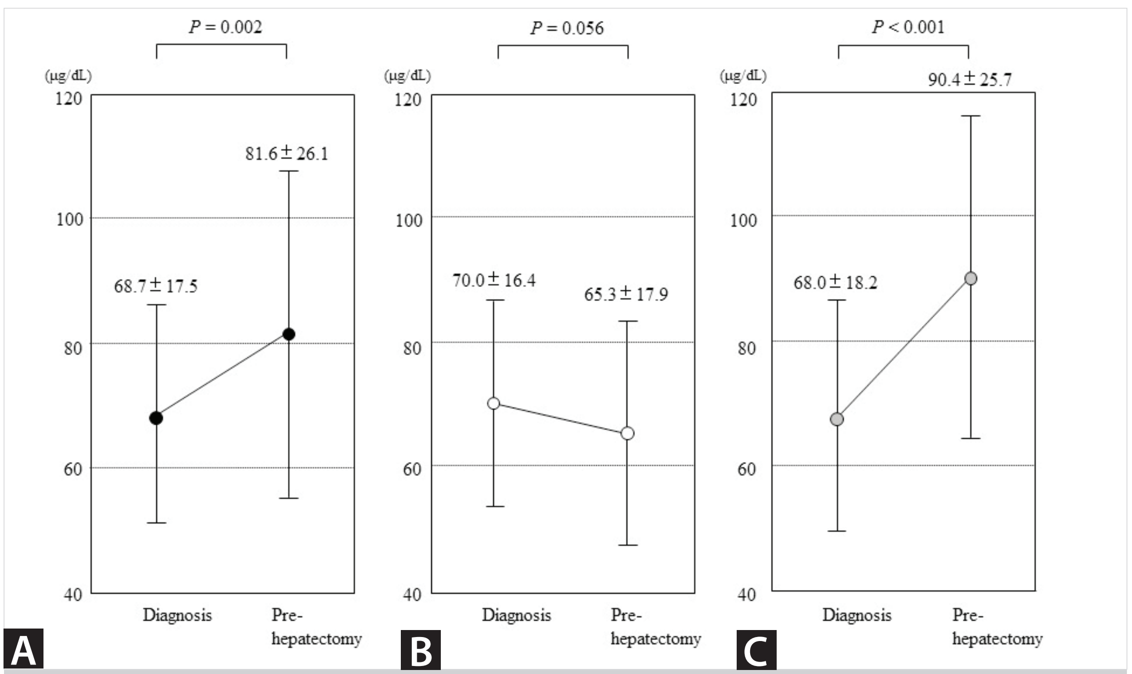

Figure 1. Changes in serum zinc concentration between serum samples taken at the time of liver cancer diagnosis and those taken shortly before hepatectomy. **A.** Considering all 77 patients in the study, serum zinc concentrations increased on average between these two time points (p= 0.002). **B.** In the 27 patients without administration of zinc, serum zinc concentrations decreased during this period (p= 0.056). **C.** In the 50 patients with administration of zinc, serum zinc concentrations increased (p< 0.001).

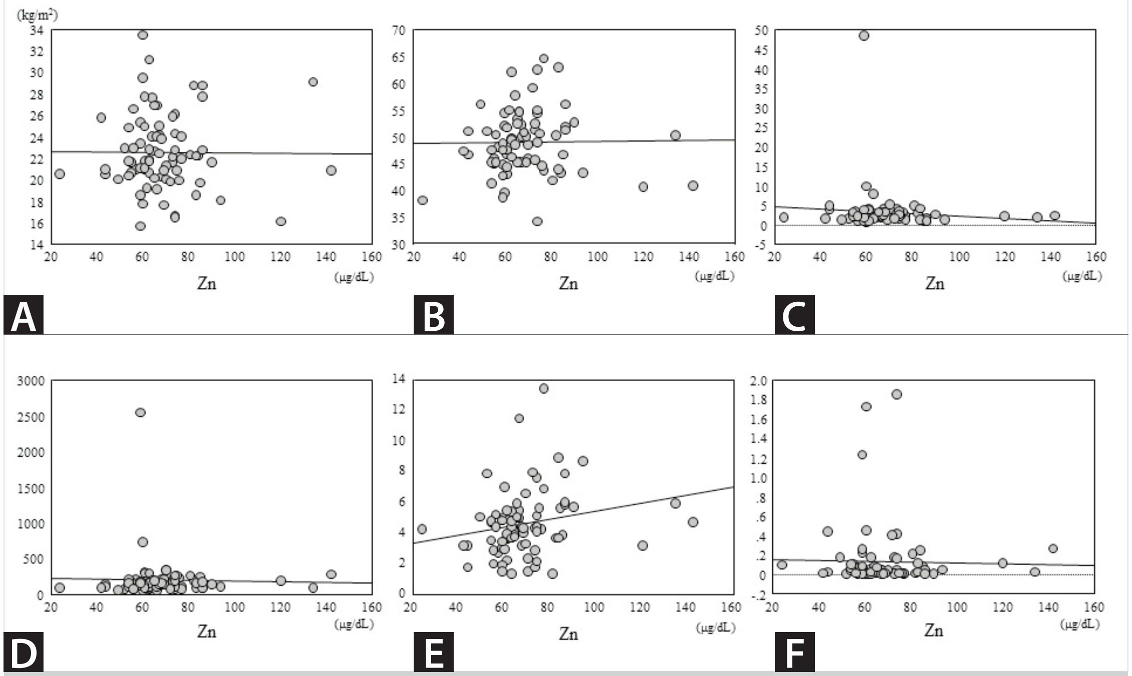

Figure 2. Scatter plots showed no relationships between zinc concentration at diagnosis and most other inflammatory or nutritional parameters. **A.** Body mass index (BMI), R= -0.005, p= 0.963. **B.** Onodera prognostic nutritional index (PNI), R= 0.014, p= 0.902. **C.** Neutrophil-to-lymphocyte ratio (NLR), R= -0.096, p= 0.407. **D.** PLR (R= -0.028, p= 0.809). **F.** CAR (R= -0.022, p= 0.853). **E.** Only LMR showed some correlation, though weak, with serum zinc at diagnosis (R= 0.213, p= 0.063).

GPS of 1 or 2 (n= 20) was 72.5 μg/dL (24-142, p= 0.546). Serum zinc concentrations (median with range) according to CONUT score were 64.5 μg/dL (44-134) in patients with a score of 0 (n= 18), 64.0 μg/dL (42-86) in those with a score of 1 (n= 21), 69.0 μg/dL (44-142) in those with a score of 2 (n= 21), 60.0 μg/dL (24-86) in those with a score of 3 (n= 11), and 73.0 μg/dL (59-120) in those with a score of 4 (n= 5). No relationship was evident between serum zinc and CONUT score.

When patients were divided into two groups defined by median serum zinc concentration at diagnosis, no difference was evident between the high-zinc group (66 μg/dL or more) and the low-zinc group (less than 66 μg/dL) in terms of Onodera PNI (median, 50.14; range, 34.11-64.5) vs. median, 47.54; range, 38.19-62.15; p= 0.282); NLR (median, 2.444; range, 1.018-5.206 vs. median, 2.229; range, 0.818-48.5; p= 0.855); PLR (median, 152.1; range, 63.6-345.8 vs. 147.45; range, 57.11-2542; p= 0.457); or CAR (median, 0.028; range, 0.002-1.852 vs. median, 0.03; range, 0.002-1.72; p= 0.8625).

Only for LMR was a difference evident between the high-zinc group (median, 4.464; range, 1.349-13.5) and the low-zinc group (median, 3.979; range, 1.389-7.956; p= 0.045)

Impact of Serum Zn Concentration on Short-Term Outcome

Patients were divided into two groups relative to the median pre-hepatectomy zinc concentration for all patients: a high-zinc group (≥75 μg/dL, n= 39; H group) and a low-zinc group (<75 μg/dL, n= 38, L group). Demographic and clinical characteristics were comparable between groups (Table 1). The H group included more patients who received zinc supplementation before hepatectomy (36/39 or 92%) than did the L group (14/38 or 37%; p< 0.001). Although segmentectomy or more extensive liver resection tended to be performed more frequently in the H group (23/39 or 59%) than in the L group (16/38 or 42%; p= 0.174), no other differences concerning surgical details were observed between these groups.

Mortality occurred in one patient in the H group (2.6%; p> 0.999) from aspiration pneumonia. Considering both groups together, 43 nonfatal complications occurred in 36 patients, including grade A liver failure in 11, pulmonary embolism and/or deep vein thrombosis in seven, biliary complications in six, delirium in four, pneumonia in two, and others in 13. No difference in postoperative morbidity was evident between the groups (p= 0.173). In the L group, Clavien-Dindo grade 1 postoperative complications occurred in seven patients, grade 2 in 11, and grade 3a in three. In the H group, grade 1 complications occurred in three patients, grade 2, in eight, grade 3a in two, grade 3b in one, and grade 5 in one. Overall, the two groups showed no difference in grade of postoperative complications (p= 0.498). Hospital stay was comparable between the L group (13 days, 8-55) and the H group (12 days, 4-49; p= 0.591; (Table 2).

Table 1. Patient characteristics in low- and high-zinc groups

	Low zinc (n= 38)	High zinc (n= 39)	p
Patient-related			
Age in years	71.5 (49-87)	69 (50-86)	0.968
Sex			
Male	24	23	0.816
Female	14	16	
Disease			
Metastasis	18	20	0.909
HCC	10	12	
CCC	2	2	
Biliary cancers	6	4	
Others	2	1	
ICGR15, %	10.7 (3.1-41.24)	8.97 (3.21-35.85)	0.369
Pathologic F number			
0	1	5	0.390
1	26	23	
2	1	2	
3	1	1	
4	2	5	
(NA)	(7)	(3)	
Serum Zn, µg/dL			
At diagnosis of tumor	63 (24-86)	69 (42-142)	0.055
Preoperative	62.5 (47-74)	99 (75-167)	<0.001
Treatment-related			
Zn administration	14	36	<0.001
Extent of hepatectomy			
Partial	22	16	0.224
Segment	3	1	
Two segments	0	3	
Section	9	11	
Hemiliver	4	7	
Trisection	0	1	
Surgical approach			
Open	23	26	0.640
Laparoscopic	15	13	
Duration of operation, min	415 (176-653)	440 (168-727)	0.935
Blood loss, mL	255 (0-740)	200 (0-1086)	0.192

Zn: Zinc, HCC: Hepatocellular carcinoma, CCC: Cholangiocarcinoma, Ca: Cancer, ICGR15: Indocyanine green retention rate at 15 minutes, NA: Not available.

Table 2. Short-term outcome			
	Low zinc (n= 38)	High zinc (n= 39)	p
Morbidity	21 (55.3%)	15 (38.5%)	0.173
Clavien-Dindo class			
1	7	3	0.498
2	11	8	
3a	3	2	
3b	0	1	
5	0	1	
Details of complications			
Liver failure, grade A	8	3	0.072
PE/DVT	5	2	
Biliary-related complications	5	1	
Delirium	3	1	
Pneumonia	1	1	
Others	3	10	
Mortality	0	1 (2.6%)	>0.999
Hospital stay, days	13 (8-55)	12 (4-49)	0.591

PE: Pulmonary embolism, DVT: Deep vein thrombosis.

Impact of Preoperative Serum Zinc Concentration on Volumetrically Measured Hypertrophy of the Future Liver Remnant

Hypertrophy ratio in terms of liver volume corresponding to FLR after hepatectomy (TELV at postoperative week 1/FLR volume before resection ×100) was 127.7 ± 24.7% in the H group (median 122.5%, range 88.9 to 200.7%) and 115.9 ± 16.7% in the L group (115.2%, 91.0-157.4). Hypertrophy ratio in the H group was greater than in the L group (p= 0.024) (Figure 3A). When hypertrophy ratios were compared within subgroups defined by extent of resection, hypertrophy ratios were similar between H and L groups among patients who underwent partial resection: (L group, mean ± SD, 115.6 ± 17.2%; median with range, 110.2%, 9-152.4%; H group, 122.2 ± 20.5% and 122.2%, 88.9% to 152.3%; p= 0.450) (Figure 3B). Among the patients who underwent extended resections with segmentectomy or resections of greater extent, hypertrophy ratio was greater in the H group (130.9 ± 26.8%; 122.5%, 96.2 to 200.7) than in the L group (116.4 ± 16.5%; 115.6%, 91.4 to 157.4; p= 0.037) (Figure 3C).

According to CT volumetry-based calculations of actual liver volume in all patients, FLR volume before hepatectomy in the H group was smaller than in the L group (H group, 784.9 ± 240.3 vs. 935.5 ± 225.8 in the L group, p= 0.016) (Figure 4A). However, liver resection rate calculated as (resected liver volume/TELV before hepatectomy) ×100 (%) did not differ between the L group (19.7 ±15.3%) and the H group (26.5 ± 20.1%; p= 0.17). In the subgroup of patients who underwent extended resection, a similar tendency was observed (699.3 ± 241.7 in the H group vs. 878.6 ± 189.4 in the L group, p= 0.019) (Figure 4C), while TELV one week after resection did not differ between H and L groups (Figure 4).

DISCUSSION

Time intervals between serum sampling for zinc measurement at diagnosis and at sampling at time of hepatectomy did not differ between patients who received zinc supplementation (22.5 ± 12.5 days) and those who did not (39.4 ± 38.7, p= 0.172). However, serum zinc gradually decreased during the preoperative period in patients without zinc supplementation, possibly reflecting tumor burden, stress related to preoperative examinations, and treatments preceding hepatectomy such as chemotherapy. This suggests that zinc supplementation during the preoperative period would be desirable.

Zinc deficiency has several possible clinical manifestations including skin lesions, poor wound healing, altered mental status, and altered immune function (27). Zinc also is essential for cell differentiation and protein synthesis, which involve various metalloenzymes such as DNA polymerase and RNA polymerase. We therefore considered whether serum zinc concentration could affect such inflammatory and nutritional parameters as blood cell counts and determinations of serum proteins such as albumin and C-reactive protein. However, serum zinc concentrations showed no relation with these variables. Serum zinc also showed no influence on GPS or CONUT scores.

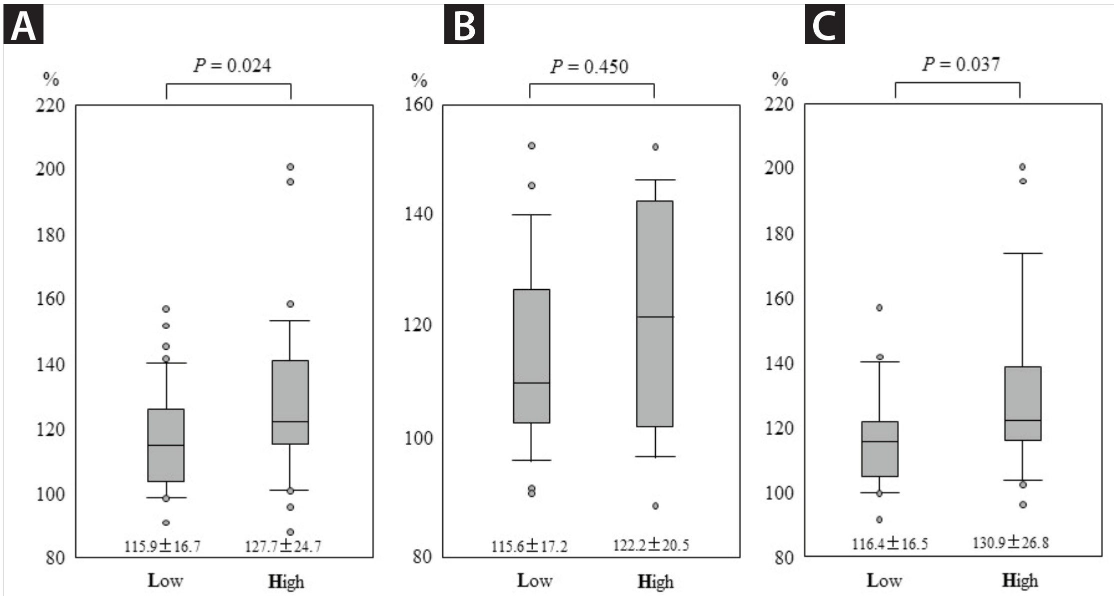

Figure 3. Hypertrophy ratio of future liver remnant volume after hepatectomy. **A.** Considering all patients, the hypertrophy ratio in patients with high serum zinc (H group) was greater than in those with a low zinc concentration (L group, p= 0.024). **B.** Among patients with partial resection, hypertrophy ratios were similar between groups (p= 0.450). **C.** Among extended resections including segmentectomy or more, the hypertrophy ratio was greater in the H group than in the L group (p= 0.037).

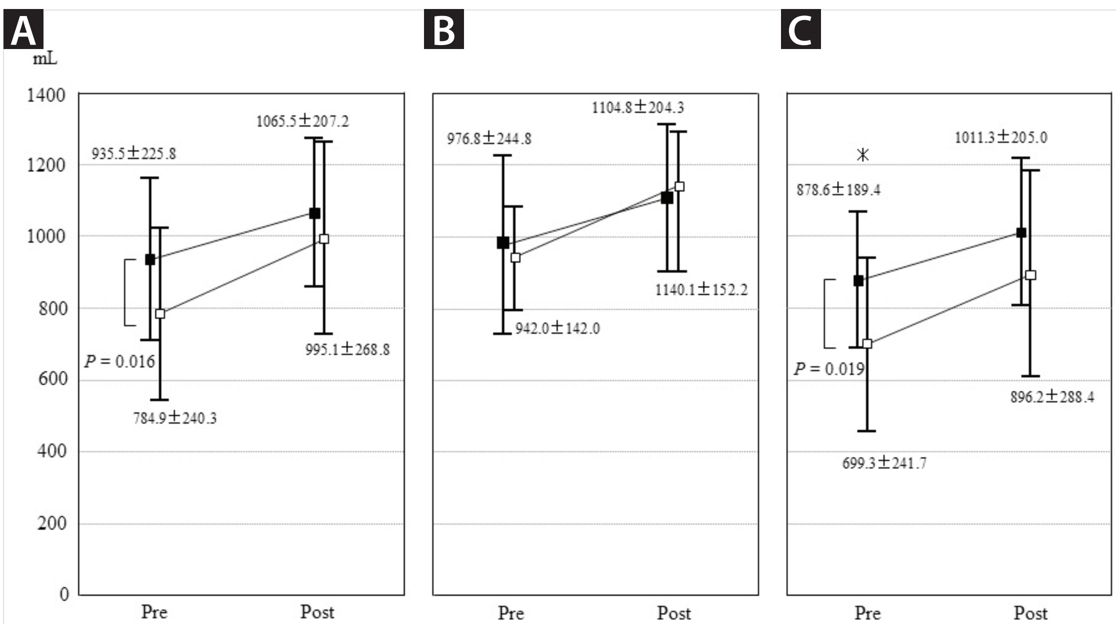

Figure 4. Future liver remnant volume at time of surgery (Pre) and one week later (Post). **A.** Considering all patients, future liver remnant (FLR) volume in patients with high serum zinc concentrations (H group, unfilled squares) was smaller preoperatively than in patients with low zinc (L group, black squares; p= 0.016), with no significant difference in volume one week later. **B.** Considering patients with partial resection, no difference in FLR volume was evident between zinc-defined groups at either time point. **C.** Among patients with extended resection, preoperative FLR volume in the H group was smaller than in the L group (p= 0.019). Total estimated liver volume one week after resection was not different between H and L groups, regardless of the extent of resection.

Further, when patients were divided into two groups according to serum zinc concentration at diagnosis, no differences in inflammatory/nutritional parameters between the groups were apparent except for LMR. Short-term results included no differences of morbidity, mortality, or hospital stay related to patients' pre-hepatectomy serum zinc concentrations.

LMR is a proposed systemic inflammatory marker that has been investigated as a prognosticator in patients with solid tumors; a low lymphocyte count might suggest a diminished immunologic reaction against the tumor, while tumor-associated macrophages, which are derived from circulating monocyte populations, have been reported to favor tumor progression (28,29). Accordingly, a low LMR generally suggests a poor prognosis. Metallothionein mRNA has been reported to rapidly increase in mononuclear cells upon consumption of a zinc supplement, and metallothionein expression appears related to zinc accumulation in various organs (30,31). Although relationships between serum zinc concentration and LMR remain unclear, changes in serum zinc may affect inflammatory/nutritional status, especially in patients with a substantial tumor burden.

Liver hypertrophy ratio in terms of liver volume corresponding to the FLR after hepatectomy was greater in patients with high preoperative serum zinc concentrations than in those with low serum zinc, which suggests that in some way zinc contributes to liver regeneration after hepatectomy. Shortly after injury, regenerating cells require large amounts of zinc; to meet this requirement, metallothionein is induced. Mocchegiani et al. have reported that plasma zinc concentrations are reduced at 24 h and 48 h after a surgical procedure (32). Partial hepatectomy reduces plasma zinc concentrations during the early postoperative period (24 to 48 hours), when it is needed for compensatory liver growth. Later in the period of compensatory liver growth (7^{th} to 15^{th} days), zinc balance is restored to positivity, accompanied by normalization of serum zinc concentration. Further, liver concentrations of metallothionein, which correlate with zinc accumulation, are increased at 24 and 48 hours after hepatectomy (31). In normal human liver, zinc is the predominant metal bound to metallothionein (33). Several reports present details of zinc transfer of metallothioneins to various metalloenzymes and transcription factors. Cellular metallothionein turnover and accumulation are directly linked to zinc availability (31). To summarize, adequate serum zinc concentrations are highly important during the early stages of remnant liver regeneration (34).

Various reports have estimated the time needed for complete restoration of liver volume after hepatectomy as two to six months (35-38). Differences in time requirement between reports may reflect methods of observation, extent of resection, and presence and nature of coexisting liver disease. After an intermediate or large resection, 90% or more of initial volume was found to be regained within one to three months in livers without additional coexisting disease, while livers with coexisting pathology attained only 70% to 80% of initial volume after two to five months (1). In our present study, background liver fibrosis graded according to Japanese general rules for clinical and pathologic study of primary liver cancer represented only F0 or F1 in at least 70% of patients in both zinc-defined groups, showing no intergroup difference (39). A functional parameter, the ICGR15 value, also was comparable between our H and L groups. We evaluated regenerative liver volume soon after surgery because zinc should influence regeneration most conspicuously during the early period, while background liver status might have more confounding effect at a later time. According to our results, more hypertrophy was observed in patients with high preoperative serum zinc concentrations than in those with lower concentrations, especially when a hepatic segment or more was resected, which suggests that high serum zinc had a positive effect on liver regeneration. Liver regeneration after hepatectomy has been found to be influenced by extent of resection. Residual liver volume immediately following hepatectomy was smaller in the H group than in the L group, while TELV one week after resection was similar between these groups. The difference in liver hypertrophy in terms of liver volume corresponding to FLR after hepatectomy therefore could have been influenced by differences in extent of liver resection between groups. However, while liver resection ratio relative to whole-liver volume was similar between the L and H groups, the actual residual liver volume after hepatectomy was smaller in the H than the L group. Therefore, the stimulus for postoperative liver hypertrophy might have been equally intense in both groups. Comparisons involving larger numbers of patients might resolve the uncertainty.

CONCLUSION

Serum zinc influenced remnant liver hypertrophy independently of previously reported nutritional and inflammatory markers. Although preoperative serum zinc concentration had no impact on short-term outcome, it appeared to affect liver regeneration in the period immediately following liver resection, including in patients with extended resections.

Ethics Committee Approval: This study was approved by Showa University Ethics Committee (Approval no: 2023-002-A, Date: 13.04.2023).

Peer-review: Externally peer-reviewed.

Author Contributions: Concept - KT; Design - KT; Supervision - KT; Data Collection and/or Processing - YT, HO, AN, YM; Analysis and/or Interpretation - YT, HO, YM; Literature Review - KT; Writer - YT, KT; Critical Review - KT.

Conflict of Interest: The authors have no conflicts of interest to declare.

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ORİJİNAL ÇALIŞMA-ÖZET
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Çinko kısmi rezeksiyon sonrası karaciğer rejenerasyonunu destekler

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ÖZET

Giriş ve Amaç: Kapsamlı karaciğer tümörü yükünün güvenli bir şekilde ortadan kaldırılması, kısa bir süre içinde büyük miktarda çinko gerektiren kalan karaciğerin yenilenmesine bağlıdır. Çinkonun yenilenmeyi nasıl etkilediğini inceledik.

Gereç ve Yöntem: Serum çinkonun kısa vadeli sonuçları ve kalan karaciğer rejenerasyonunu nasıl etkilediğini belirlemek için hepatektomi geçiren 77 hastada karaciğer kanseri tanısı sonrasında perioperatif serum çinko konsantrasyonlarını ölçtük.

Bulgular: Teşhis anındaki serum çinko konsantrasyonu, lenfosit/monosit oranı ile zayıf bir korelasyon dışında enflamatuvar veya beslenme parametreleriyle hiçbir korelasyon göstermedi. Hastalar hepatektomi öncesi yüksek çinko grubuna (≥75 µg/dL, n= 39, H grubu) ve düşük çinko grubuna (<75 µg/dL, n= 38, L grubu) ayrıldığında, kısa dönem sonuçlar mortalite (p> 0,999), morbidite (p= 0,490) ve hastanede kalış (p= 0,591) gibi değerler gruplar arasında farklılık göstermedi. Bununla birlikte, H grubunda hepatektomi sonrası gelecekte oluşacak karaciğer kalıntısındaki hipertrofi (orijinal hacmin %127,7 ± %24,7'si), L grubuna göre daha fazlaydı (%115,9 ± %16,7, p= 0,024). Genişletilmiş hepatektomili hasta alt grubunda hipertrofi H grubunda %130,9 ± 2 ± %6,8 iken L grubunda %116,4 ± %16,5 idi (p= 0,037).

Sonuç: Tanı anında daha yüksek serum çinkosu, gelecekteki karaciğer kalıntısında daha fazla hipertrofi ile ilişkiliydi.

Anahtar Kelimeler: Çinko, hepatektomi, karaciğer rejenerasyonu, beslenme parametreleri, kısa vadeli sonuç

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