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Effect of constipation on hospitalization due to heart failure in patients after myocardial infarction: a retrospective cohort study

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Abstract

Background Patients with constipation after acute heart failure (HF) are at high risk of rehospitalization due to HF. Although HF after myocardial infarction (MI) affects patient outcomes, the relationship between constipation and patient prognosis after MI remains unclear. In this study, we evaluated the effects of constipation on the prognosis of patients with MI, focusing on hospitalization due to HF.

Methods We investigated 1,324 patients with MI admitted to our hospital between January 2012 and December 2023 (mean age, 68 ± 14 years; 76% males). Patients with constipation were defined as those using laxatives regularly.

Results During the follow-up period (median, 2.7 years), 115 patients died, and 99 were re-hospitalized due to HF. Landmark Kaplan–Meier analyses revealed incidences of 7.8% and 2.1% hospitalization due to HF from 0 to 0.5 years (log-rank: $p < 0.0001$) and 4.8% and 3.9% from 0.5 to 3 years (log-rank: $p = 0.17$) among patients with and without constipation, respectively. The adjusted Cox proportional hazards analysis revealed a significantly higher risk of hospitalization due to HF from 0 to 0.5 years in patients with constipation than in those without it (hazard ratio, 2.12; 95% confidence interval, 1.07–4.19; $p = 0.032$). However, no significant difference was found from 0.5 to 3 years (hazard ratio, 0.86; 95% confidence interval, 0.47–1.57; $p = 0.63$).

Conclusions Constipation was strongly associated with a higher risk of hospitalization due to HF in patients with MI during the first 6 months after discharge.

Keywords Constipation, Heart failure, Hospitalization, Prognosis, Myocardial infarction

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Background

Myocardial infarction (MI) is one of the most important public health problems owing to its poor prognosis in both acute and chronic phases. Despite recent improvements in the treatment of MI, it remains the most common cause of heart failure (HF), and the development of HF after MI has a significant impact on patient outcomes. Prevention of HF remains a major clinical challenge [1].

Constipation is a common gastrointestinal disorder characterized by straining, hard stools, decreased bowel movement frequency, and abdominal distension. The prevalence of functional constipation has been reported to be 10.1–11.7% in recent studies [2, 3]. Interestingly, among functional gastrointestinal disorders, only constipation is significantly associated with an increased risk of mortality [4]. Chronic constipation is also common in patients with cardiovascular disorders. In addition, constipation status and laxative use are associated with high risks of all-cause death, incident coronary heart disease, and ischemic stroke in the general population [5]. Furthermore, we previously reported that constipation is associated with a higher risk of rehospitalization for HF in patients with acute HF [6]. Thus, these studies have clarified the importance of constipation in patients with cardiovascular disease. However, to the best of our knowledge, no study has examined the relationship between constipation and prognosis of patients after MI. Therefore, in this study, we aimed to investigate the association between constipation and the prognosis of patients after acute MI, with a focus on hospitalization due to HF.

Methods

Study population

Overall, 1,429 consecutive patients with acute MI were admitted to our hospital between January 2012 and December 2023. We excluded 105 patients who died in the hospital and included the remaining 1,324 patients. Acute MI was diagnosed according to the universal definition [7, 8].

Study protocol

We analyzed various patient characteristics, such as age, sex, body mass index (BMI), coronary risk factors, patient status at admission and in the hospital, and medication use after hospitalization. Diagnoses of hypertension, diabetes mellitus, and dyslipidemia were obtained from patients' medical records or histories of previous medical therapy. The patients were divided into two groups according to the presence or absence of constipation. Constipation was defined as the prescription of at least one type of laxative for regular use at the time of discharge. The types of laxatives included bulk-forming laxatives, osmotic laxatives, stimulant laxatives, chloride channel activators, guanylate cyclase C agonists, bile acid transporter inhibitors, and opioid receptor antagonists. Although this definition differs from that used in a previous large-scale study [5], it is conceptually similar to the approach adopted in another recent study [9], which defined constipation based on continued laxative prescriptions after discharge in a nationwide administrative database in Japan.

Clinical outcomes

The outcomes of this study were all-cause mortality and hospitalization due to HF after hospital discharge. The diagnosis of HF was based on the Framingham Study criteria. Medical charts were retrospectively reviewed to obtain data on post-discharge outcomes, which were assessed according to the patients' history of regular hospital visits after discharge and contact with their family and family doctors. This study conformed to the principles outlined in the Declaration of Helsinki and was approved by the Ethics Committee of Sendai City Medical Center (approval number: 2024-0059). Informed consent for this study was obtained on an opt-out basis. The need for written informed consent was waived because this was a retrospective study using anonymized clinical data, in accordance with the ethical guidelines for medical and health research involving human subjects. Information regarding the study was publicly disclosed for participants to opt out.

Statistical methods

Continuous data were presented as means ± standard deviations (or as medians and interquartile ranges) and compared using Student's t-test. Categorical data were presented as percentages and were compared using the chi-squared test. Kaplan–Meier estimates were compared using log-rank tests to evaluate the association between the presence of constipation and the risk of all-cause death and hospitalization due to HF. Landmark analyses were conducted from 0 to 0.5 years and from 0.5 to 3.0 years of follow-up. Since the incidence of HF post-MI discharge is highest during the first 6 months of follow-up [10], half a year was set as a landmark point to investigate whether the risk of hospitalization due to HF could persist beyond half a year in patients with constipation. We constructed three Cox proportional hazards regression models: an unadjusted model, an age- and sex-adjusted model, and a fully adjusted model. In the fully adjusted model, we included the presence of constipation and the eight baseline covariates reported as influencing factors for the development of HF after MI [1] (age, sex, history of MI, hypertension, diabetes mellitus, atrial fibrillation, estimated glomerular filtration rate [mL/min/1.73m^2], and prescription of diuretics). Cox proportional hazards analyses were performed for

Table 1 Baseline characteristics before propensity score matching

	Overall cohort (*n* = 1,324)	Constipation (+) (*n* = 253)	Constipation (-) (*n* = 1,071)	*p*	SMD
Age (years)	68 ± 14	74 ± 11	66 ± 14	< 0.0001	0.636
Male	1,011 (76%)	173 (68%)	838 (78%)	0.0009	-0.225
Body mass index (kg/m^2)	24.3 ± 3.7	23.7 ± 3.5	24.4 ± 3.7	0.0078	-0.194
Diabetes mellitus	417 (31%)	89 (35%)	328 (31%)	0.16	0.085
Dyslipidemia	783 (59%)	142 (56%)	641 (60%)	0.28	-0.081
Hypertension	863 (65%)	182 (72%)	681 (64%)	0.012	0.172
Previous MI admission	192 (15%)	50 (20%)	142 (13%)	0.0082	0.189
Previous HF admission	26 (2%)	8 (3%)	18 (2%)	0.13	0.064
Previous stroke admission	146/1315 (11%)	54/252 (21%)	92/1063 (9%)	< 0.0001	0.336
Atrial fibrillation	67 (5%)	17 (7%)	50 (5%)	0.18	0.084
Chronic hemodialysis	21 (2%)	4 (2%)	17 (2%)	0.99	-0.0005

SMD, standardized mean difference; MI, myocardial infarction; HF, heart failure

Table 2 Patient status, laboratory findings, and medications before propensity score matching

	Overall cohort (*n* = 1,324)	Constipation (+) (*n* = 253)	Constipation (-) (*n* = 1,071)	*p*	SMD
Killip class (1/2/3/4)	1,101/97/59/67	174/30/26/23	927/67/33/44	< 0.0001	
Killip class ≥ 2	223 (17%)	79 (31%)	144 (13%)	< 0.0001	0.435
Primary PCI	1,087 (82%)	202 (80%)	885 (83%)	0.30	-0.077
LVEF (%)	58 ± 11	57 ± 11	58 ± 11	0.14	-0.091
LVEF < 50%	340/1,310 (26%)	66/246 (27%)	274/1,064 (26%)	0.73	0.023
Hemoglobin (g/dL)	13.9 ± 2.1	13.2 ± 2.1	14.0 ± 2.0	< 0.0001	-0.390
Creatinine (mg/dL)	0.86 [0.72, 1.04]	0.89 [0.75, 1.12]	0.86 [0.71, 1.02]	0.064	0.122
eGFR (mL/min/1.73m^2)	65.2 ± 21.8	58.6 ± 20.9	66.8 ± 21.7	< 0.0001	-0.385
BNP (pg/mL)	48.3 [15.8, 162.2]	74.2 [26.6, 252.0]	43.1 [14.8, 144.8]	0.0053	0.222
Peak CK (U/L)	743 [217, 2197]	797 [285, 2005]	719 [207, 2235]	0.92	-0.007
Medication					
ACEI/ARB/ARNI	1,064 (80%)	194 (77%)	870 (81%)	0.10	-0.098
Beta-blockers	859 (65%)	166 (66%)	693 (65%)	0.79	0.021
Diuretics	316 (24%)	89 (35%)	227 (21%)	< 0.0001	0.316
Loop diuretics	234 (18%)	70 (28%)	164 (15%)	< 0.0001	0.320
Thiazides	64 (5%)	18 (7%)	46 (4%)	0.066	0.132
MRA	101 (8%)	25 (10%)	76 (7%)	0.13	0.108
Statin	1,073 (81%)	203 (80%)	870 (81%)	0.72	-0.025

SMD, standardized mean difference; PCI, percutaneous coronary intervention; LVEF, left ventricular ejection fraction; eGFR, estimated glomerular filtration rate; BNP, B-type natriuretic peptide; CK, creatine kinase; ACEI, angiotensin-converting enzyme inhibitors; ARB, angiotensin receptor blockers; ARNI, angiotensin receptor neprilysin inhibitors; MRA, mineralocorticoid receptor antagonists

the 0–0.5- and 0.5–3-year periods. Furthermore, using the propensity score for the presence of constipation estimated for each participant using the eight baseline covariates above, 249 pairs of patients with and without constipation were matched, and Kaplan–Meier estimates were compared using log-rank tests to evaluate the risk of all-cause death and hospitalization due to HF in both groups. Additionally, a sensitivity analysis was performed by stratifying patients into three groups according to the number of prescribed laxatives at discharge (none, one type, and two or more types) to explore dose-response relationships. Statistical significance was set at $p < 0.05$. All statistical analyses were performed using JMP software (JMP version 17.2.0; SAS Institute, Cary, North Carolina, USA) and R software (http://www.r-project.org/).

Results

Patient characteristics

In this study, we retrospectively investigated 1,324 patients with a mean age of 68 ± 14 years, of whom 76% were men. Among the patients, 19.1% ($n = 253$) used laxatives regularly. Table 1 shows the comparison of the baseline characteristics of the patients with and without constipation at the time of admission. The group with constipation was older and had a higher proportion of female patients, a lower mean BMI, and higher rates of hypertension, and an admission history for MI and stroke compared to the group without constipation. Table 2 presents details on patient status, laboratory findings at admission, and medications at discharge. The Killip class score was higher in patients with constipation. The proportion of patients who underwent primary percutaneous coronary intervention was similar in both groups. Hemoglobin levels and estimated glomerular filtration rates were significantly lower, and B-natriuretic peptide levels were higher in patients with constipation than in those without constipation. No significant differences in medication use at discharge were observed between the two groups.

Kaplan–Meier analysis and landmark analyses

During the follow-up period (mean ± standard deviation [SD], 3.6 ± 3.2 [median, 2.7] years), 115 (8.7%) patients died, and readmission due to HF was observed in 99 (7.5%) patients (32 and 67 with and without constipation, respectively). Kaplan–Meier analysis revealed that the risks of death and hospitalization due to HF were significantly higher among patients with constipation than among those without constipation (log-rank $p = 0.023$ and 0.0001, respectively) (Fig. 1). Figure 2 presents the results of the landmark Kaplan–Meier analyses for the 0–0.5-year and 0.5–3-year incidences of all-cause death. The incidence rates of all-cause death from 0 to 0.5 years were 4.1% and 2.7% for patients with and without constipation, respectively (log-rank $p = 0.26$), and those from 0.5 to 3 years were 6.3% and 3.8%, respectively (log-rank $p = 0.048$). Figure 3 presents the results of the landmark Kaplan–Meier analyses for the 0–0.5-year and 0.5–3-year incidences of hospitalization due to HF. For patients with and without constipation, the incidence rates of hospitalization due to HF in the periods of 0–0.5 and 0.5–3 years were 7.8% and 2.1% (log-rank $p < 0.0001$) and 4.8% and 3.9%, respectively (log-rank $p = 0.17$).

Cox proportional hazard models

Table 3 presents the results of the Cox proportional hazards models for all-cause deaths for the periods of 0–0.5 years and 0.5–3 years. The risk of all-cause death did not differ significantly between the two groups in either the model or period. Table 4 presents the results of the Cox proportional hazards models for hospitalization due to HF for 0–0.5 years and 0.5–3 years. No significant differences were observed between the two groups in the three models from 0.5 to 3 years. However, from 0 to 0.5 years, patients with constipation had a significantly higher risk of hospitalization due to HF than those without constipation. Compared with the patients without constipation, the patients with constipation had hazard ratios of 3.86 (95% confidence interval, 2.02–7.36), 2.66 (95% confidence interval, 1.38–5.14), and 2.12 (95% confidence interval, 1.07–4.19) for hospitalization due to HF in the unadjusted, age, sex-adjusted, and fully adjusted models, respectively. Atrial fibrillation, estimated glomerular filtration rate, prescription of diuretics, age, and diabetes mellitus were significant independent variables for hospitalization due to HF from 0 to 0.5 years. We assessed the proportional hazards assumption of the fully adjusted Cox proportional hazards models using Schoenfeld

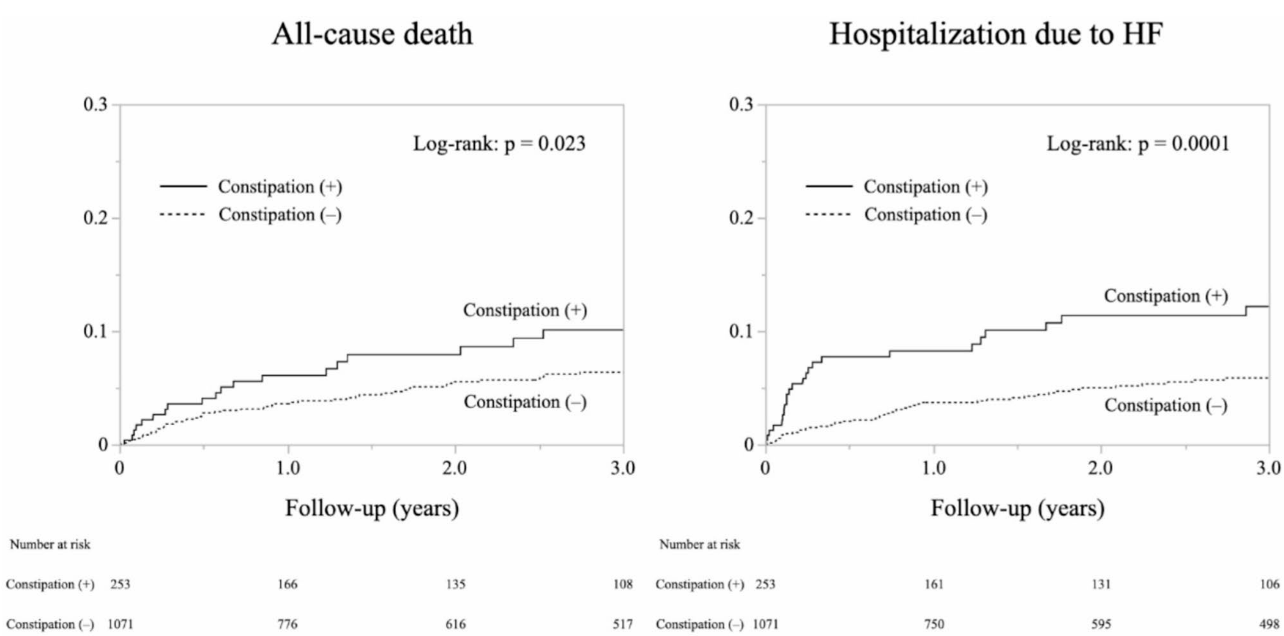

Fig. 1 Kaplan–Meier curves for all-cause death and HF hospitalization after MI. Kaplan-Meier curves for all-cause death and hospitalization due to HF in patients with and without constipation after MI before propensity score matching. Solid lines represent patients with constipation, and dotted lines represent those without constipation. The log-rank p-values are shown. HF, heart failure; MI, myocardial infarction

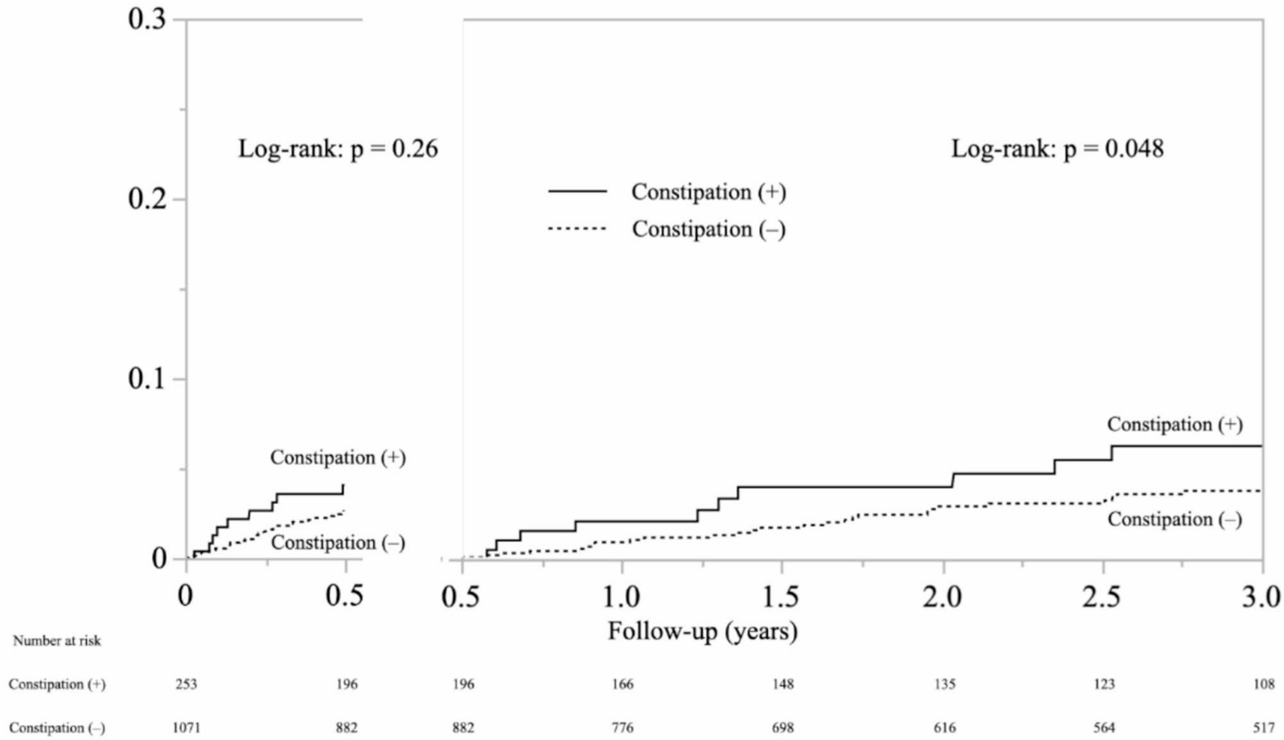

Fig. 2 Landmark analysis for all-cause death before propensity score matching. Landmark analysis showing the cumulative incidence of all-cause death at 0–0.5 years and 0.5–3 years in patients with and without constipation after MI, before propensity score matching. Solid lines represent patients with constipation, and dotted lines represent those without constipation. The log-rank *p*-values are shown. MI, myocardial infarction

residuals for each time period and outcome. For all models, including those for HF hospitalization and all-cause death at both 0–0.5 years and 0.5–3 years, the global tests indicated no significant violation of the proportional hazards assumption (all p-values > 0.09). Importantly, the primary variable of interest, constipation, consistently showed no evidence of time dependency (all p-values > 0.15). While age exhibited borderline time-dependency in the model for all-cause death beyond 0.5 years ($p = 0.041$), the overall proportional hazards assumption was satisfied for each model.

Kaplan–Meier analysis after propensity score matching

To evaluate the balance between patients with and without constipation, we performed propensity score matching using eight covariates. After matching, the standardized mean differences for all covariates were below 0.1, indicating that the groups were well-balanced (Supplementary Table 1). Supplementary Fig. 1 presents landmark Kaplan–Meier analyses for the 0–0.5-year and 0.5–3-year incidences of all-cause death. All-cause mortality at 0–0.5 years and 0.5–3 years was not significantly different between patients with and without constipation (log-rank $p = 0.87$ and 0.92, respectively). Supplementary Fig. 2 presents landmark Kaplan–Meier analyses for the 0–0.5-year and 0.5–3-year incidences of hospitalization due to HF. For patients with and without constipation, the incidence rates of hospitalization due to HF from 0 to 0.5 years and from 0.5 to 3 years were 8.0% and 3.2% (log-rank $p = 0.030$) and 4.2% and 9.0%, respectively (log-rank $p = 0.98$).

Sensitivity analysis based on the number of prescribed laxatives

To further explore the association between the severity of constipation and clinical outcomes, we stratified patients into three groups according to the number of laxatives prescribed at discharge: no laxative ($n = 1071$), one laxative ($n = 231$), and two or more laxatives ($n = 22$). Within half a year post-MI discharge, all-cause death occurred in 26, 7, and 2 patients in the no-, one-, and two-or-more-laxative groups, respectively. Hospitalization due to HF occurred in 20, 15, and 2 patients, respectively. Kaplan-Meier analyses demonstrated a stepwise increase in event rates with a higher number of prescribed laxatives (Supplementary Fig. 3). Cox proportional hazards models within half a year post-MI discharge, adjusted for eight covariates, showed that compared with the no-laxative group, the hazard ratios for all-cause death were 0.82 (95% confidence interval, 0.35–1.95) for the one-laxative group and 2.00 (95% confidence interval, 0.43–9.23) for the two-or-more-laxatives group. The corresponding

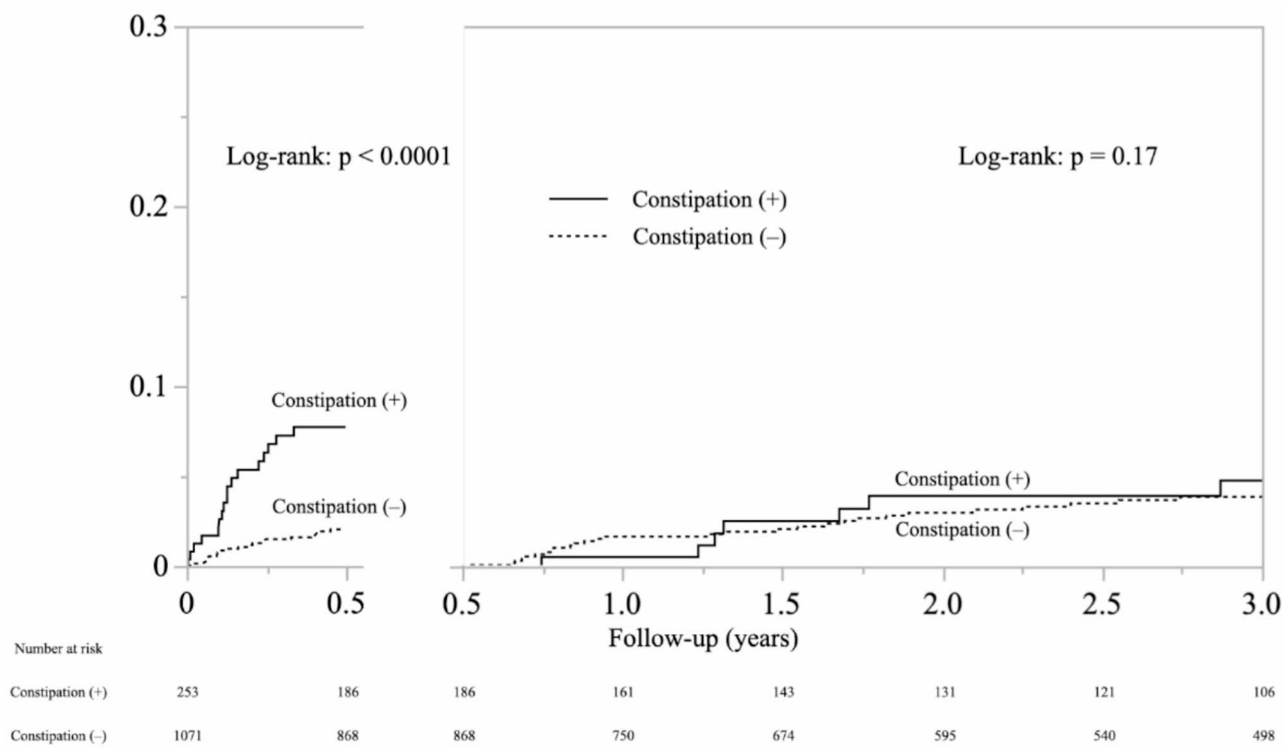

Fig. 3 Landmark analysis for HF hospitalization before propensity score matching. Landmark analysis showing the cumulative incidence of hospitalization due to HF at 0–0.5 years and 0.5–3 years in patients with and without constipation after MI, before propensity score matching. Solid lines represent patients with constipation, and dotted lines represent those without constipation. The log-rank *p*-values are shown. The multivariable-adjusted hazard ratio for heart failure hospitalization within 0–0.5 years is 2.12 (95% CI, 1.07–4.19; $p = 0.032$). HF, heart failure; MI, myocardial infarction; CI, confidence interval

Table 3 Cox proportional hazards models for all-cause death by constipation status

0–0.5 years	Hazard ratio	95% CI	*p*
Unadjusted			
Constipation (–)	1.0 (reference)		
Constipation (+)	1.54	0.72–3.29	0.26
Age and sex-adjusted			
Constipation (–)	1.0 (reference)		
Constipation (+)	1.04	0.48–2.24	0.92
Fully adjusted			
Constipation (–)	1.0 (reference)		
Constipation (+)	0.94	0.43–2.08	0.88
0.5–3.0 years	**Hazard ratio**	**95% CI**	***p***
Unadjusted			
Constipation (–)	1.0 (reference)		
Constipation (+)	1.65	0.99–2.71	0.050
Age and sex-adjusted			
Constipation (–)	1.0 (reference)		
Constipation (+)	1.18	0.72–1.95	0.51
Fully adjusted			
Constipation (–)	1.0 (reference)		
Constipation (+)	1.02	0.61–1.71	0.93

CI, confidence interval

Table 4 Cox proportional hazards models for HF hospitalization by constipation status

0–0.5 years	Hazard ratio	95% CI	*p*
Unadjusted			
Constipation (–)	1.0 (reference)		
Constipation (+)	3.86	2.02–7.36	< 0.0001
Age and sex-adjusted			
Constipation (–)	1.0 (reference)		
Constipation (+)	2.66	1.38–5.14	0.0034
Fully adjusted			
Constipation (–)	1.0 (reference)		
Constipation (+)	2.12	1.07–4.19	0.032
0.5–3.0 years	**Hazard ratio**	**95% CI**	***p***
Unadjusted			
Constipation (–)	1.0 (reference)		
Constipation (+)	1.50	0.84–2.69	0.17
Age and sex-adjusted			
Constipation (–)	1.0 (reference)		
Constipation (+)	1.05	0.59–1.89	0.86
Fully adjusted			
Constipation (–)	1.0 (reference)		
Constipation (+)	0.86	0.47–1.57	0.63

HF, heart failure; CI, confidence interval

hazard ratios for hospitalization due to HF were 2.23

(95% confidence interval, 1.11–4.47) and 1.41 (95% confidence interval, 0.30–6.70), respectively (Supplementary Table 2).

Discussion

The major finding of this study was that patients with constipation after MI had a significantly higher risk of hospitalization due to HF than those without constipation, especially between 0 and 0.5 years after discharge.

Two possible mechanisms for the onset and worsening of HF due to constipation

Constipation is common in patients with cardiovascular diseases. Aging is an important risk factor for both constipation and cardiovascular diseases, and treatment of cardiovascular diseases, especially HF, may also promote constipation owing to restricted water intake and diuretic use [11]. Furthermore, constipation may worsen the prognosis of patients with HF through two possible mechanisms: changes in the intestinal microbiota and straining with difficult bowel movements.

First, changes in the intestinal microbiota may promote atherosclerosis through increased trimethylamine-N-oxide (TMAO) production. TMAO, a dietary phosphatidylcholine metabolite [12], is primarily metabolized by the intestinal microbiota [13]. Elevated TMAO levels vary depending on the microbiota composition [14] and have been associated with an increased risk of death, myocardial infarction, stroke [13–15], and adverse outcomes in patients with HF [16, 17]. However, whether constipation alters the intestinal microbiota to increase TMAO production has not been clearly established, and this hypothesis was not directly tested in the present study.

Second, straining during defecation, the most common symptom of chronic constipation [18], may cause transient increases in blood pressure. This hemodynamic stress could potentially trigger cardiovascular events, including HF. Similar temporary blood pressure surges, such as the morning surge, have been linked to higher risks of cardiovascular events [19] and HF admission [20]. However, the causal mechanisms linking straining to cardiovascular outcomes remain speculative and were not investigated in this study. Both proposed mechanisms are plausible but remain hypothesis that warrant further investigation in future mechanistic or prospective cohort studies.

Association between constipation status and hospitalization due to HF

Approximately 30% of patients with HF have constipation, and these patients have a 2.6-fold increased risk of rehospitalization due to HF [6]. Constipation status may be strongly related to rehospitalization due to HF after acute HF. In this study, we investigated the association between constipation and the prognosis of patients after acute MI, focusing on hospitalization due to HF.

Regarding mortality, the patients with constipation had a higher risk than those without constipation in the crude Kaplan–Meier analysis, but the association was no longer statistically significant in the adjusted Cox proportional hazards analysis. In the crude Kaplan–Meier analysis, hospitalization due to HF was significantly higher among patients with constipation than among those without constipation. Interestingly, the landmark analysis showed a significant difference in hospitalization due to HF up to half a year post-MI discharge; however, no difference was observed thereafter between the two groups. There are several risk factors for the development of HF after MI, including age, female sex, history of MI, hypertension, diabetes, glomerular filtration rate, and atrial fibrillation [1]. Therefore, we constructed an adjusted Cox proportional model including these variables; this model demonstrated similar results in that there was a large difference in hospitalization due to HF between the two groups within half a year post-MI discharge. Similar results were obtained in the Kaplan–Meier analysis after propensity score matching for the same variables. In a supplementary analysis stratifying patients into three groups based on the number of prescribed laxatives, we observed a stepwise increase in the incidence of hospitalization due to HF, with a significantly higher risk in those prescribed even a single laxative. Although the group prescribed two or more types of laxatives was too small for definitive conclusions, this dose-response trend supports the robustness of our primary binary classification. Furthermore, recent evidence also suggests that constipation may increase bleeding risk in patients with atrial fibrillation, which could lead to anemia and potentially worsen HF outcomes by compromising oxygen delivery and increasing cardiac workload [21]. Although our study did not assess bleeding events or longitudinal hemoglobin changes, this type hypothesis warrants further investigation in future research.

Period of high incidence of hospitalization due to HF after MI

HF is prevalent in patients with MI [1]. The incidence of HF post-MI discharge is the highest in the first 6 months, and it levels off and remains stable at a rate of 1.3–2.2% per year afterward [10]. A recent study reported that the incidence of hospitalization due to HF after MI was 2.6–3.4 per 100 patient-years during a median follow-up of 17.9 months [22]. The incidence of MI in Japan is relatively low, but the incidence of HF after MI is 3.6–6.1% within 891 ± 668 days [23] and 4.1% over 2 years [24], which does not appear to be much different from that in Western countries. However, in this study, the incidence of hospitalization due to HF at 0 to 0.5 years after MI was 7.8% for patients with constipation and 2.1% for those without it. Patients with constipation in our study may have been at a higher risk of hospitalization due to HF than those in previous studies.

One possible reason for the high incidence of hospitalization due to HF within half a year after MI may be that patients were in a vulnerable period when they were unable to compensate for the decline in cardiac function, making them more susceptible to the adverse effects of straining.

Importance of preventing HF after MI

Post-MI patients represent a high-risk group for the development of HF, which has a significant impact on outcomes such as adverse events, impaired quality of life, and lower survival [1]. Therefore, the prevention of HF after MI is a major clinical challenge that needs to be addressed. Depending on cardiac function after MI, guidelines recommend the use of beta-blockers, angiotensin-converting enzyme inhibitors/angiotensin receptor blockers, mineralocorticoid receptor antagonists, and statins as pharmacotherapy to prevent HF after the onset of MI [1]. In addition, improving lifestyle habits, such as reducing salt intake, exercising, quitting smoking, improving adherence, and self-care management are also very important. The results of this study suggest that management of constipation may improve the short-term prognosis of patients after MI. Constipation can become a new target for the management of HF in the future, especially for preventing hospitalization due to HF after acute HF and MI. However, further investigations are needed to determine whether controlling constipation can prevent the development of HF after MI.

Study limitations

This study has some limitations:

Single-center design and patient demographics

This was a retrospective observational study conducted at a single center in Japan, with a relatively small sample size and predominantly male participants. The generalizability of the findings may be limited due to ethnic, dietary, and lifestyle differences compared to Western populations.

Definition of constipation

Constipation was defined based on the prescription of laxatives for regular use at discharge, rather than using standardized symptom-based criteria such as the ROME IV [25]. This may have resulted in misclassification: patients with functional constipation who were not prescribed laxatives may have been excluded from the constipation group, while patients receiving laxatives for prophylactic or short-term reasons may have been incorrectly included. As this was a retrospective study, symptom-based assessment was not feasible. Nonetheless, similar pragmatic definition has been used in a previous study [9].

No data on laxative duration

We were unable to distinguish between chronic and short-term use of laxatives, precluding a sensitivity analysis based in treatment duration. Future studies should include more detailed prescription data.

Residual confounding

Despite multivariable adjustment and propensity score matching, residual confounding from unmeasured variables such as frailty, dietary fiber intake, or medication adherence cannot be ruled out. E-values for the hazard ratios in the unadjusted, age- and sex-adjusted, and fully adjusted models were 3.46, 2.10, and 1.34, respectively, suggesting that a moderate unmeasured confounder would be required to fully account for the observed association. However, given the relatively small number of events, these E-values should be interpreted cautiously.

Time-dependent association not formally modeled

Although landmark analyses suggested a stronger association between constipation and hospitalization due to HF within the first 0.5 years post-discharge, we did not include a formal interaction term between constipation and time in the final Cox models. The limited number of events ($n = 37$ within 0.5 years) reduced the statistical power to detect such an interaction.

Need for external validation

To confirm the generalizability and clinical relevance of our findings, multicenter studies with larger, more diverse patient populations are warranted. Future research should also explore how constipation should be managed in patients after MI, and whether proactive constipation management can improve long-term cardiovascular outcomes in this high-risk group.

Conclusions

The present study showed that constipation was strongly associated with a higher risk of hospitalization due to HF in patients with MI during the first 6 months after discharge. Constipation may be a new target to prevent the development of HF after MI.

Abbreviations

ACEI	angiotensin-converting enzyme inhibitors
ARB	angiotensin receptor blockers
ARNI	angiotensin receptor neprilysin inhibitors
BMI	body mass index
BNP	B-type natriuretic peptide
CK	creatine kinase

CI	confidence interval
eGFR	estimated glomerular filtration rate
HF	heart failure
LVEF	left ventricular ejection fraction
MI	myocardial infarction
MRA	mineralocorticoid receptor antagonists
PCI	percutaneous coronary intervention
SD	standard deviation
SMD	standardized mean difference
TMAO	trimethylamine-N-oxide

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12872-025-04874-7.

Supplementary Material 1

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Author contributions
Conceptualization, Formal analysis, Methodology: S.N. Data curation, Investigation: S.N., S.S., A.T., T.O., K.N., and T.T. Writing– review & editing: S.N., S.S., A.T., T.O., K.N., T.T., Y.N., and S.Y. All authors read and approved the final manuscript.

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Data availability
The datasets generated and/or analyzed during the current study are not publicly available due to patient privacy and ethical restrictions. De-identified data may be made available from the corresponding author upon reasonable request and with approval from the Ethics Committee of Sendai City Medical Center.

Declarations

Ethics approval and consent to participate
This study conformed to the principles outlined in the Declaration of Helsinki and was approved by the Ethics Committee of Sendai City Medical Center (approval number: 2024-0059). Informed consent for this study was obtained on an opt-out basis.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

Clinical trial number
Not applicable.

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