Original Article

Preoperative physical functional status affects the long-term outcomes of elderly patients with open abdomen

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Aim: The mortality rates among elderly patients with open abdomen (OA) are high, and pre-existing comorbidities could affect the outcomes. However, long-term prognosis remains uncertain. We examined long-term outcomes in elderly patients with OA, focusing on physical functional status.

Methods: We undertook a retrospective cohort study between 2007 and 2017 at a single institution. Patients with OA who were aged ≥65 years were categorized into two groups: "good preoperative functional status" group (GFG) and "poor preoperative functional status" group (PFG). The GFG was defined as Eastern Cooperative Oncology Group/World Health Organization performance status (PS) 0–1, whereas PFG was defined as PS 2–4. The primary outcomes were survival and PS 2 years following the initial surgery.

Results: Of the 53 participants, 38 and 15 were assigned to the GFG and PFG, respectively. The PFG (median age, 81 years) was older than the GFG (median age, 75.5 years; $P = 0.040$). The 2-year survival rate was 39.5% in GFG and 6.7% in PFG, and Kaplan–Meier analysis showed significant difference ($P = 0.022$). Among all patients, the PS at 2 years was worse than that at discharge ($P = 0.007$). Preoperative PS was correlated with 2-year survival ($P = 0.003$), whereas age and pre-existing comorbidities were not.

Conclusion: The long-term outcomes of elderly patients with OA are affected by the preoperative physical functional status. Functional status deteriorates in a time-dependent manner. Therefore, surgery requiring OA must be carefully considered for elderly patients with PS 2 or higher.

Key words: Non-trauma, physical functional status, prognosis, survival curve

INTRODUCTION

RECENTLY, OPEN ABDOMEN (OA) has become a common protocol in surgery for non-trauma patients,[1–3] and the role of OA in emergency surgery is becoming more important. Because of ongoing aging in many countries, particularly in developed countries, opportunities to carry out OA in elderly patients are expected to increase.

A survey suggested that the prognosis for elderly patients with OA is poor,[4] and in-hospital mortality of elderly patients with OA was reportedly high in other surveys.[5–7] In addition, pre-existing comorbidities were suggested to affect the outcomes.[5,8,9] Some studies evaluated the long-term physical functional status after OA[10–13]; however, the long-term physical functional status of elderly patients with OA has not been studied previously. The long-term prognosis of elderly patients with OA remains uncertain.

We aimed to examine the long-term survival and physical functional status in elderly patients with OA, focusing on preoperative functional status.

METHODS

Study design and setting

WE UNDERTOOK A retrospective cohort study at the National Hospital Organization Disaster Medical Center (Tokyo, Japan) by examining the medical records of

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all patients who underwent emergency laparotomy between January 2007 and December 2017, including those with OA. The institutional review board approved this study, and the study was carried out in accordance with the ethical standards established in the Declaration of Helsinki 1964 and its later amendments.

Elderly patients (aged ≥65 years) who underwent surgery with OA were enrolled. Those who underwent OA were followed up every few months by surgeons who carried out the surgery in our outpatient clinic. Patients who did not attend the outpatient clinic were followed up on the telephone for physical status and development of complications. We monitored the patients' medical records for 2 years following the initial surgery. We defined OA as treatment comprising a deliberate temporary abdominal closure (TAC) and specified postoperative management. Patients with cardiopulmonary arrest on admission were excluded.

Surgical interventions

There was no prior protocol for OA, and the surgeon in charge determined the indications for and management of OA in each case. Following the initial surgery, a second operation was carried out within 12–72 h, and fascial closure was attempted as soon as feasible.

We used a homemade vacuum pack technique for wound closure, in which a modified Barker's method in the TAC was used for negative pressure wound therapy.[14] No commercial device was used for the TAC.

Data collection and processing

We documented age, sex, body mass index, prevalence of comorbidities, and cause of OA as baseline characteristics and collected indications for OA, procedures in initial surgery, and methods of TAC. In addition, we examined the following variables as outcomes: number of days of survival, physical functional status (preoperative, at hospital discharge, 1 year following the initial surgery, and 2 years following the initial surgery), number of days in the hospital, number of days in the intensive care unit, number of days with a ventilator, tracheostomy, number of operations, primary fascial closure, number of days with OA, enteral nutrition, and complications.

We used the Charlson comorbidity index (CCI) to measure comorbidities with treatment.[15] The Eastern Cooperative Oncology Group/World Health Organization performance status (ECOG/WHO PS) was used to indicate physical functional status.[16] "Complication" was defined as an adverse event, equivalent to grade ≥2 in the Clavien–Dindo classification, that required pharmacological treatment.[17]

Study outcomes

The primary outcomes were survival and the physical performance status 2 years following the initial surgery. We defined ECOG/WHO PS 0–1 as representing good physical functional status and PS 2–5 as representing poor functional status. We categorized the patients into two groups by preoperative physical functional status and compared them: preoperative ECOG/WHO PS 0–1 as a good functional status group (GFG) and PS 2–4 as a poor functional status group (PFG).

Statistical analysis

Continuous variables were calculated as medians and interquartile ranges (IQRs). We used the log–rank test to compare the Kaplan–Meier survival curve of the two groups and the Wilcoxon signed-rank test to analyze time-dependent changes in the physical functional status. In addition, we used the Cox proportional hazards model to analyze prognostic factors. Other categorical variables were analyzed using Fischer's exact test, and other continuous variables using the Mann–Whitney *U*-test. A P-value < 0.05 was considered statistically significant. The EZR (Saitama Medical Center, Jichi Medical University, Saitama, Japan) graphical user interface for R (The R Foundation for Statistical Computing, Vienna, Austria) was used to complete the statistical analysis.[18]

RESULTS

Patient characteristics

DURING THE STUDY period, we undertook emergency laparotomies on 1598 patients, of whom 74 (4.6%) were treated with OA. Of these 74 patients, 55 aged ≥65 years were enrolled. Two patients were lost to follow-up, and the data of the remaining 53 patients were analyzed (Fig. 1).

Of these 53 patients, 39 were men and 14 were women; 38 (71.7%) had PS 0–1 and were assigned to the GFG, and the remaining 15 (28.3%) had PS 2–4 and were assigned to the PFG. The median age of all patients was 76 years (IQR, 72–82 years). The median body mass index of all patients, except for one in the GFG whose height was not available, was 21.8 (IQR, 19–23.9). In most cases, the reason for surgery was not trauma (49 patients [92.5%]). Every patient had comorbidities under treatment at admission. The PFG (median age, 81 years) was older than the GFG (median age, 75.5 years; $P = 0.040$). However, no significant

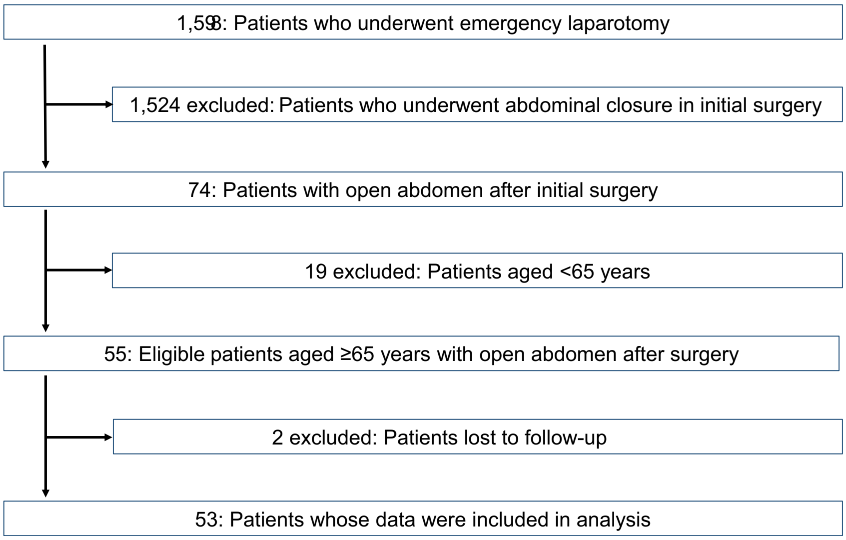

Fig. 1. Flow diagram of study enrollment of elderly patients with open abdomen.

difference in other variables was found between the two groups. Baseline characteristics are presented in Table 1.

Cause, indications, and procedures in initial surgery

The causes of OA are presented in Table 2.

The most common OA indication in the GFG was concern for bowel viability (n = 22), followed by abdominal compartment syndrome (n = 6), hemorrhage (n = 5), physiological instability (n = 3), and severe peritonitis (n = 2). Similarly, the concern for bowel viability (n = 13) was the most common indication in the PFG, followed by abdominal compartment syndrome (n = 1) and physiologic instability (n = 1). The differences in the indications between the two groups were not significant.

A total of 66 procedures were carried out in the initial surgery, 47 in the GFG and 19 in the PFG. The most common procedure was small bowel resection (22 in the GFG and 10 in the PFG), the second most common procedure was colon resection (15 in the GFG and 7 in the PFG), and the third most common procedure was establishment of hemostasis (4 in the GFG). Thrombectomy and stoma replacement followed.

Most TACs comprised negative pressure wound therapy in both groups. Patients in the GFG underwent individualized vacuum pack closure (n = 37) and skin-only closure (n = 1), whereas patients in the PFG underwent individualized vacuum pack closure (n = 14) and silo closure (n = 1).

Long-term survival and physical status

At the 2-year follow-up, the overall survival rate was 30.2%; 37 patients died and 16 patients survived. In the GFG, the rate of the 2-year survival was 39.5%, whereas in the PFG it was 6.7%. Kaplan–Meier analysis revealed a significant difference in the 2-year survival between the two groups (P = 0.022; Fig. 2).

Nine patients who survived to discharge died during the follow-up period, five from the GFG and four from the PFG. Of these patients, three had an ECOG/WHO score of PS 0 at hospital discharge, two had PS 2, two had PS 3, and two had PS 4. The three patients with a good physical status at hospital discharge died of ruptured abdominal aortic aneurysm, sepsis, and sudden cardiac arrest, respectively. Of the six with a poor physical status at discharge, five patients died of pneumonia caused by progressive disuse and one died of disseminated intravascular coagulation caused by malignant disease. All patients with a poor physical status at hospital discharge died during the follow-up period.

Overall changes in physical functional status during the 2-year follow-up period are presented in Fig. 3. The proportions of patients with good physical status at hospital discharge, 1 year later, and 2 years later were 35.8%, 34.0%, and 28.3%, respectively. Of the 53 patients, 15 had good physical functional status 2 years following the initial surgery. Of the 16 survivors after 2 years, 10 had an ECOG/WHO score of PS 0, five had PS 1, and one had PS 2. The physical functional status at hospital discharge was significantly different from that 2 years later (P = 0.007).

Table 1. Characteristics of elderly patients with open abdomen, grouped according to functional status

	Good functional status group (n = 38)	Poor functional status group (n = 15)	P-value
Age (years)	75.5 (70–80)	81 (75–85)	0.040
Male sex	29 (76.3)	10 (66.7)	0.504
Body mass index	21.8 (18.7–23.9)†	21.8 (20.0–23.7)	0.592
Non-trauma	34 (89.5)	15 (100.0)	0.568
ECOG/WHO performance status	1 (0–1)	2 (2–3)	<0.001
Comorbidity	38 (100)	15 (100.0)	1.000
Number of comorbidities per patient	2 (1.25–3.00)	2 (1.50–2.50)	0.941
Charlson comorbidity index	3 (2.0–4.0)	3 (2.5–4.5)	0.274
Hypertension	20 (52.6)	5 (33.3)	0.237
Cancer	11 (28.9)	3 (20.0)	0.732
Diabetes mellitus	7 (18.4)	5 (33.3)	0.286
Chronic renal failure	4 (10.5)	2 (13.3)	1.000
Arrhythmia	4 (10.5)	1 (6.7)	1.000
Ischemic heart disease	4 (10.5)	1 (6.7)	1.000
Cerebral infarction	2 (5.3)	3 (20.0)	0.131
Chronic heart failure	3 (7.9)	0 (0.0)	0.550
Chronic obstructive pulmonary disease	2 (5.3)	1 (6.7)	1.000
Liver cirrhosis	2 (5.3)	1 (6.7)	1.000
Peptic ulcer	1 (2.6)	1 (6.7)	0.490
Psychiatric disorder	0 (0.0)	2 (13.3)	0.076

Data are expressed as number (percentage), or median (interquartile range).
ECOG, Eastern Cooperative Oncology Group; WHO, World Health Organization.
†Height of one patient was not available; therefore, the patient was excluded.

Table 2. Cause of open abdomen in 53 elderly patients

	Good functional status group (n = 38)	Poor functional status group (n = 15)	P-value
Trauma	4	0	0.564
Non-trauma	34	15	0.564
Non-occlusive mesenteric ischemia	13	6	0.756
Superior mesenteric artery occlusion	7	4	0.708
Small bowel obstruction	4	2	1.000
Gangrenous ischemic colitis	3	2	0.614
Colon perforation	2	0	1.000
Postoperative leakage	2	0	1.000
Others	3	1	1.000

Complications

The overall rate of complications was high (98.1%); 97.4% of patients in the GFG and 100% of those in the PFG had complications. A total of 80 complications occurred, including enterocutaneous fistulas (n = 2) and ventral hernias (n = 2). One enterocutaneous fistula resolved spontaneously, and the other resolved following surgical resection. One ventral hernia developed during the initial hospital stay and observed without surgery. The other ventral hernia developed in the outpatient clinic after abdominal reconstruction with thigh muscle flap because of failure of the primary fascial closure, then it was also observed. The rates of complications in the two groups were not significantly different (Table 3).

Prognostic factors

Preoperative ECOG/WHO PS significantly correlated with 2-year survival (P = 0.003). Conversely, age and CCI were not significantly correlated with 2-year survival (Table 4).

DISCUSSION

OUR STUDY RESULTS suggested that preoperative physical functional status strongly affects long-term outcomes. In elderly patients with PS 2 or higher, the prognosis can be especially poor. In addition, survival and physical functional status deteriorated in a time-dependent manner.

To date, only a few studies have focused on the long-term survival of elderly patients who underwent OA. Arhinful *et al*. reported an overall 2-year survival rate of 41% among octogenarian patients with OA,[8] which was higher than the 30.2% overall 2-year survival rate in our study. However, the common causes of OA in their study—ruptured abdominal aortic aneurysm and perforated viscus—were different from those of our study. In a multicenter prospective study of non-trauma OA by Bruns *et al*.,[9] the rate of 6-month mortality was 64%, which was significantly high, in patients aged ≥80 years. Another multicenter survey of non-trauma OA revealed a 1-year mortality of 33%, but that study included patients younger than those in our study; the mean age was 62.7 years.[19]

Some researchers have evaluated the long-term functional outcome of OA. Kriwanek *et al*., using the 36-item short form survey (SF-36) to evaluate long-term physical

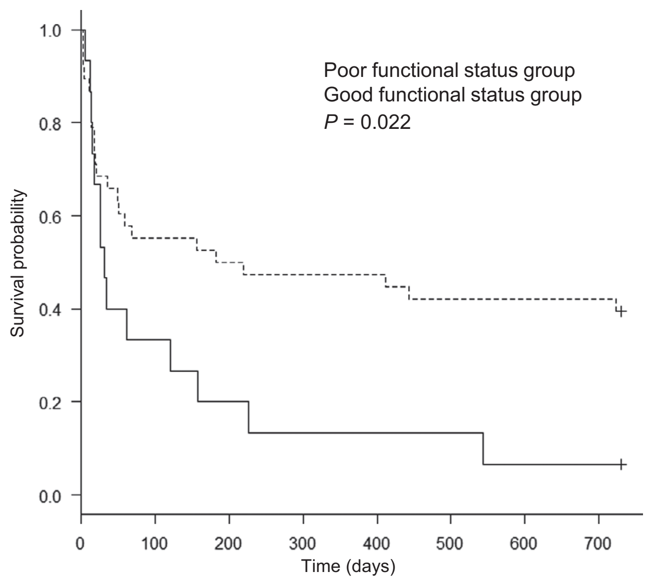

Fig. 2. Comparison of long-term survival between good and poor functional status groups of elderly patients with open abdomen.

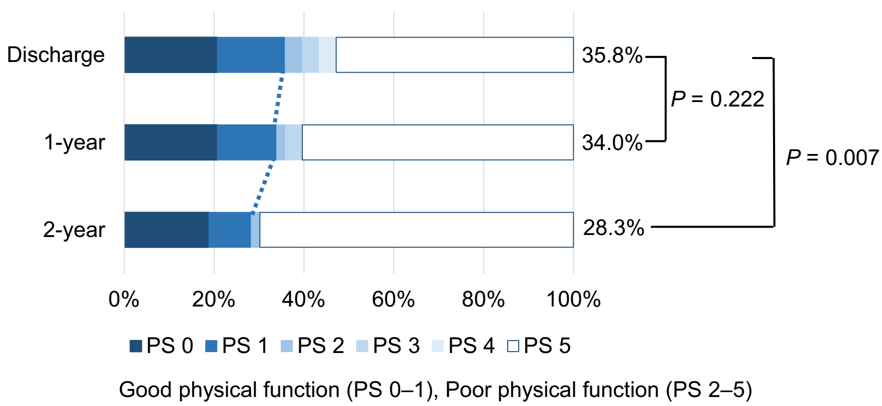

Fig. 3. Change in long-term physical status in all patients enrolled in this study of elderly patients with open abdomen. The broken blue line indicates the boundary between good physical status (PS 0-1) and poor physical status (PS2-5). PS, performance status.

functional outcomes, interviewed surviving non-trauma patients with OA, aged 50–60 years.[10] Bosscha *et al*. also evaluated the long-term physical functional outcomes in younger patients, with a mean age of 56 years.[20] Other studies on long-term physical functional status did not include elderly patients with OA.[11,13] We could not find any study on the long-term physical functional outcomes of elderly patients with OA.

Table 3. Comparison of outcomes between good and poor functional status groups of elderly patients with open abdomen

	Good functional status group (*n* = 38)	Poor functional status group (*n* = 15)	*P*-value
2-year survival	15 (39.5)	1 (6.7)	0.022
2-year good physical status	14 (36.8)	1 (6.7)	0.041
Hospital days	48.5 (18–79)	31.0 (16–65)	0.521
ICU days	15.5 (10–21)	15.0 (12–19)	1.000
Ventilator days	12.5 (7–21)	15.0 (7–26)	0.790
Tracheostomy	16 (42.1)	7 (46.7)	0.769
Number of explorations	2 (2–3)	2 (2–3)	0.771
Primary fascial closure	37 (97.4)	14 (93.3)	0.490
Time to primary fascial closure, POD†	2 (2–3)	2 (1–3)	0.413
Enteral nutrition	32 (84.2)	12 (80.0)	0.701
Start of enteral nutrition, POD‡	7 (5–9)	7 (3–9)	0.596
Complications	37 (97.4)	15 (100)	1.000
Surgical site infection	10 (26.3)	4 (26.7)	1.000
Pneumonia	6 (15.8)	4 (26.7)	0.442
Anastomotic leakage	3 (7.9)	2 (13.3)	0.614
Enteritis	3 (7.9)	1 (6.7)	1.000
Gastrointestinal bleeding	3 (7.9)	1 (6.7)	1.000
Short bowel syndrome	3 (7.9)	1 (6.7)	1.000
Bloodstream infection	3 (7.9)	0 (0.0)	0.550
Urinary tract infection	2 (5.3)	1 (6.7)	1.000
Cerebral infarction	1 (2.6)	2 (13.3)	0.190
Enterocutaneous fistula	2 (5.3)	0 (0.0)	1.000
Pulmonary embolism	2 (5.3)	0 (0)	1.000

Data are expressed as number (percentage), or median (interquartile range).
ICU, intensive care unit; POD postoperative day.
†Only patients who underwent primary fascial closure were included.
‡Only patients who underwent enteral nutrition were included.

In general, age, pre-existing comorbidities, and physical functional status have been considered to affect postoperative morbidity and mortality.[21–23] Reportedly, CCIs of 3 or 4 were associated with poor prognosis in an emergency surgery setting.[24,25] However, elderly patients who required OA, as in this study, naturally have many pre-existing comorbidities. In our study, the median baseline CCI was 3 in both groups. Therefore, we hypothesized that preoperative physical functional status affected prognosis in this population more than did age and comorbidities. We chose ECOG/WHO PS to assess preoperative physical functional status because this scoring system is widely used, simple to apply, and provides numerical indicators. In fact, our study revealed that ECOG/WHO PS, but not age or CCI, correlated with long-term prognosis.

The complication rate in our study was very high in both groups (97.4% in the GFG and 100% in the PFG). However, it is not easy to compare such rates with those in other existing studies. We included minor complications that required only pharmacological treatment, but most studies included only major complications that required invasive interventions. Nevertheless, the complication rates of non-trauma patients were generally high (40%–86%).[5,8,26,27] We found that elderly patients with OA developed various infectious complications that required only pharmacological treatment. We consider that treatment for infectious complications is substantially important for a good prognosis.

The limitations of this study were as follows. First, it is a retrospective, observational, single-institutional study with a small sample size. Second, statistical power might not have

Table 4. Factors prognostic of 2-year survival among elderly patients with open abdomen

	Hazard ratio	95% confidence interval	*P*-value
Age (years)	1.016	0.967–1.068	0.523
ECOG/WHO performance status	1.712	1.208–2.426	0.003
Charlson comorbidity index	1.022	0.775–1.347	0.878

ECOG, Eastern Cooperative Oncology Group; WHO, World Health Organization.

been sufficient for multivariate analysis. Finally, the causes of OA were biased toward non-traumatic causes, especially acute mesenteric ischemia. More studies are necessary to evaluate the correlation between physical functional status and long-term prognosis of OA in elderly patients.

In conclusion, the long-term prognosis of elderly patients with OA is affected by preoperative physical functional status. Furthermore, physical functional status deteriorates in a time-dependent manner. Therefore, surgery requiring OA must be considered carefully in elderly patients with PS 2 or higher.

DISCLOSURE

Approval of the research protocol: This study was approved by the ethics committee of the National Health Organization Disaster Medical Center and it conforms to the provisions of the Declaration of Helsinki. Approval No. 2020-8.
Informed consent: The ethics committee did not require informed consent from patients for observational studies using anonymous data such as those used in this study.
Registry and the registration no. of the study/trial: N/A.
Animal studies: N/A.
Conflict of interest: None.

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