ORIGINAL ARTICLE

Prediction of postoperative delirium by comprehensive geriatric assessment among elderly patients with hip fracture

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Abstract

Background The purpose of this study is to investigate whether the preoperative comprehensive geriatric assessment (CGA) would predict postoperative delirium (POD) in elderly patients with hip fracture.

Methods This is an observational study, performed in a tertiary hospital from June 2014 to May 2018, which enrolled patients with hip fracture aged over 65 years. The comprehensive geriatric assessment for recruited patients was carried out before surgery. POD was recorded prospectively until discharge. Delirium was diagnosed according to the Confusion Assessment Method (CAM) algorithm.

Results POD occurred in 22.09% of the 507 patients who underwent hip surgery. The Barthel index, Mini-Mental State Examination (MMSE), instrumental activities of daily living (IADL), vitality index, and Geriatric Depression Scale (GDS) results were related to the occurrence of POD. All of them were independent factors related to the occurrence of POD after adjusting other traditional risk factors.

Conclusions The comprehensive geriatric assessment before hip fracture surgery can predict the occurrence of POD in elderly patients.

Keywords Comprehensive geriatric assessment · Elderly · Hip fracture · Postoperative delirium

Introduction

Delirium is defined as a change of mindset and attention deficit over time and considered to be a frequent postoperative complication among elderly patients [1]. According to different studies, the incidence of delirium varies from 10 to 40% [2]. However, the incidence of delirium after orthopedic surgery is up to 51% [3]. Postoperative delirium (POD) is related to functional and cognitive impairment, extended length of hospital stay, higher costs, and increased morbidity [4]. So, it would be useful to establish a simple and effective assessment that can predict POD. The comprehensive geriatric assessment (CGA) can be used to evaluate both cognitive function and frailty by a simple questionnaire [5]. It is used as a tool to extract problems in daily life and achieve holistic medicine in elderly adults [6]. Moreover, many studies have reported the effect of CGA on mortality and morbidity [7, 8]. But the predictive value of CGA for POD in the elderly patients with hip fracture has not been evaluated.

Hence, we carried out the observational study to investigate whether preoperative CGA would predict the occurrence of POD among the elderly patients with hip fracture.

Methods

Participants

After getting approval from the Ethics Board of China-Japan Friendship Hospital, a total of 507 patients with hip fracture from June 2014 to May 2018 met the criteria displayed in Fig. 1 and were enrolled for the study. The enrolled criteria were surgeries for hip fracture. Ineligibility criteria were age < 65 years, history of dementia (according to ICD-10), cognitive
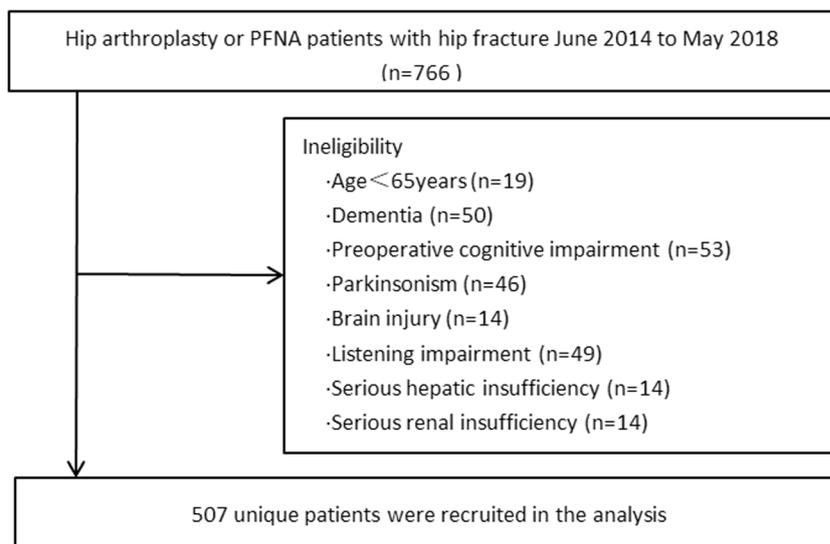
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Hip arthroplasty or PFNA patients with hip fracture June 2014 to May 2018 (n=766)

Ineligibility
·Age＜65years (n=19)
·Dementia (n=50)
·Preoperative cognitive impairment (n=53)
·Parkinsonism (n=46)
·Brain injury (n=14)
·Listening impairment (n=49)
·Serious hepatic insufficiency (n=14)
·Serious renal insufficiency (n=14)

507 unique patients were recruited in the analysis

impairment, parkinsonism, brain injury, hearing impairment, and serious hepatic or renal insufficiency. Patients were included in the study after informed consent was received from the patients themselves or their legal guardian.

Measurements

According to the requirements of the orthopedic department, preoperative CGA was performed on each patient. Two psychiatrists performed the following assessments: Mini-Mental State Examination (MMSE), Geriatric Depression Scale (GDS), vitality index, Barthel index, calculated instrumental activities of daily living (IADL) [9].

Demographics, surgical history, and laboratory findings were obtained from the medical records. The variables were as follows: age, sex, body mass index (BMI), comorbid lifestyle-related diseases, previous history (cerebrovascular, cardiovascular, or pulmonary diseases), anesthesia type (epidural or general), surgery method (hip arthroplasty or proximal femoral nail fixation), operative duration, intraoperative blood loss, and postoperative blood tests (hemoglobin (Hb), C-reactive protein (CRP), serum sodium, serum potassium, and serum magnesium).

Diagnosis of POD

The outcome of the present observational study was POD. POD was defined as delirium occurring from the moment after the surgery to discharge. POD was diagnosed by psychiatrists according to the Confusion Assessment Method (CAM) based on the Diagnostic and Statistical Manual of Mental Disorders [10]. POD was diagnosed by two independent psychiatrists who have previously been trained based on the standards in the CAM manual. Patients who were positive in at least one CAM assessment were diagnosed as POD after discussion by two psychiatrists.

Statistical analysis

We used JMP Pro (version 11; SAS Institute, Cary, NC, USA) to perform the statistical analysis. Frequency data was reported as the number and percentage of events. Continuous data was reported as mean and SD. Group comparisons of frequency data were analyzed by Student's t test and ordered categorical data by the chi-squared test. Proportional odds logistic regression was used to assess the independent effect of CGA components on POD, with the incidence of POD as the dependent variable. A p value of < 0.05 was considered statistically significant.

Results

Incidence of POD

According to the above enrolled and ineligibility criteria, 766 patients were recruited from June 2014 to May 2018 and 259 patients were ineligible. Three hundred fifty-nine patients had no POD and were categorized to the non-delirium group (130 males, 265 females). One hundred twelve patients who progressed to POD were categorized to the delirium group (44 males, 68 females). The occurrence rate of POD was 22.09%.

Comparison between the two groups

We compared a variety of variables between the two groups (Table 1). There were significant differences between the two groups in age, diabetes mellitus, cerebrovascular disease, cardiovascular disease, operative duration,

Table 1 Patients' variables

Variable	Delirium ($n = 112$)	Non-delirium ($n = 395$)		
Age (years)	82.1 ± 5.1	75.8 ± 7.6	$t = 6.652$	$p = 0.000$
Gender (M/F)	44/68	130/265	$\chi^2 = 0.809$	$p = 0.359$
BMI (kg/m^2)	22.4 ± 3.1	22.7 ± 3.2	$t = 1.079$	$p = 0.282$
Hypertension	51	235	$\chi^2 = 3.671$	$p = 0.551$
Diabetes mellitus	68	307	$\chi^2 = 7.009$	$p = 0.009$
Dyslipidemia	33	119	$\chi^2 = 3.722$	$p = 0.481$
Cerebrovascular disease	83	342	$\chi^2 = 5.301$	$p = 0.019$
Cardiovascular disease	66	299	$\chi^2 = 6.418$	$p = 0.015$
Pulmonary disease	12	45	$\chi^2 = 3.702$	$p = 0.503$
Barthel index	90.7 ± 15.2	98.9 ± 5.8	$t = 2.133$	$p = 0.034$
Vitality index	9.51 ± 0.79	9.94 ± 0.46	$t = 1.662$	$p = 0.047$
MMSE	22.3 ± 5.12	27.2 ± 2.84	$t = 3.194$	$p = 0.003$
Calculated IADL	0.81 ± 0.23	0.96 ± 0.12	$t = 2.701$	$p = 0.008$
GDS	4.30 ± 3.41	2.48 ± 2.71	$t = 2.331$	$p = 0.022$
Anesthesia	47/65	201/194	$\chi^2 = 1.421$	$p = 0.231$
Surgery	57/55	182/213	$\chi^2 = 0.419$	$p = 0.518$
Operative duration	93.7 ± 39.2	84.2 ± 30.4	$t = -1.729$	$p = 0.029$
Intraoperative blood loss	150.3 ± 85.5	125.7 ± 57.2	$t = -1.691$	$p = 0.049$
Postoperative hemoglobin	9.5 ± 2.1	9.8 ± 1.9	$t = -1.236$	$p = 0.005$
Postoperative CRP	3.6 ± 2.2	2.3 ± 1.7	$t = 3.013$	$p = 0.089$
Postoperative sodium	140.1 ± 4.5	140.8 ± 3.9	$t = 0.822$	$p = 0.349$
Postoperative potassium	4.5 ± 0.8	4.5 ± 0.6	$t = 0.299$	$p = 0.658$
Postoperative magnesium	0.70 ± 0.43	1.02 ± 0.54	$t = 2.247$	$p = 0.019$

intraoperative blood loss, postoperative Hb concentration, and postoperative magnesium concentration. At the same time, the delirium group showed lower values on the Barthel index, vitality index, MMSE, and calculated IADL but higher values on GDS, compared with the non-delirium group.

Multiple logistic regression analyses

To elucidate the effect of CGA component as a predictive variable of POD in patients undergoing hip fracture surgery, multiple logistic regression analyses were conducted. After adjusting the known risk variables, all of the CGA components were related to the occurrence of POD (Table 2).

Discussion

Delirium is one of the most common postoperative complications among elderly patients. POD is related to delayed recovery, longer hospital stay length, more medical cost, and increased mortality [4]. Siddiqi et al. reported the incidence of POD among overall inpatients was 11 to 42% [2]. But the incidence of POD among patients undergoing hip surgery was 12 to 51%, which was higher than the overall inpatients [11]. In this study, the POD occurred in 22.09% of the patients who underwent hip surgery. Different study populations and diagnostic criteria for delirium may be the reasons for the different incidences. Wong et al. reviewed 25 studies about bedside delirium diagnostic instruments and concluded that the CAM based on the Diagnostic and Statistical Manual of

Table 2 Multiple logistic regression models for the variables associated with POD

Variable	B	SE	Wals	df	Adjusted HR	p value	95% CI
Barthel index	0.072	0.036	10.272	1	1.32	0.0189	1.12–1.50
Vitality index	0.097	0.058	2.156	1	1.27	0.0376	1.01–1.78
MMSE	1.208	0.281	18.934	1	1.41	< 0.0001	1.36–1.49
Calculated IADL	0.527	0.394	20.491	1	1.59	< 0.0001	1.48–1.86
GDS	0.499	0.301	15.642	1	0.92	0.0004	0.80–1.03

MMSE mini-mental state examination, *IADL* instrumental activities of daily living, *GDS* geriatric depression scale

Mental Disorders has the best reliability and validity. In this study, delirium was diagnosed by psychiatric doctors based on the CAM on the Diagnostic and Statistical Manual of Mental Disorders, which ensures the accuracy and integrity of the study.

Although many hypotheses have been put forward to illustrate the occurrence and progression of the delirium, the true pathophysiological mechanism is not clear so far [12]. So, there is no effective method to prevent or treat POD [13]. To date, many risk factors were proposed to be related to POD, such as preoperative poor nutrition, disordered homeostasis, longer general anesthesia, more intraoperative blood loss or transfusion, larger intraoperative pressure fluctuation malnutrition, and use of benzodiazepine [14–16]. So, it is clear now that making assumptions through a single risk factor would not be adequate, because the occurrence and progression of delirium involve many risk factors [12]. Clinically, there is a need to assess all risk factors comprehensively in order to improve preventive methods. In this study, we found that preoperative CGA among elderly patients with hip fracture can predict the occurrence of POD.

In this study, apart from common risk variables for POD, for instance age, diabetes mellitus, cerebrovascular disease, cardiovascular disease, operative duration, intraoperative blood loss, postoperative Hb concentration, and postoperative magnesium concentration, all of the CGA components were related to the development of the POD. At the same time, multiple logistic regression analysis found that higher Geriatric Depression Scale, lower Mini-Mental State Examination, lower vitality index, and lower calculated IADL were related to the incidence of the POD after fully adjusting all of the other risk factors. The finding proves the significance of preoperative CGA, including Barthel index, Mini-Mental State Examination, instrumental activities of daily living, vitality index, and Geriatric Depression Scale. In addition, according to the preoperative results of CGA, the necessary preventive means can be implemented to decrease the occurrence of POD.

The components of comprehensive geriatric assessment include mainly Barthel index, vitality index, Mini-Mental State Examination, instrumental activities of daily living, and Geriatric Depression Scale. All of them are independent factors of the occurrence of POD, even adjusting all of the other risk variables. So, they would be more useful predictors for the occurrence of the POD. Szumacher et al. reported that preoperative CGA was a meaningful method to guarantee the accuracy of decision-making among elderly cancer candidates undergoing surgical operation [17]. At the same time, the CGA can predict POD in gastrointestinal cancer patients [18, 19].

This study has some limitations. It is a single-center study. And the hospital is a tertiary institution in China. So, there must be some selective bias, and the conclusion needs to be further confirmed by a multi-center study.

In conclusion, preoperative CGA among the elderly patients with hip fracture would be a valuable tool for predicting POD.

Compliance with ethical standards The study was approved by the Ethics Board of China-Japan Friendship Hospital.

Conflict of interest The authors declare that they have no conflict of interest.

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