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Effectiveness of a continuous interactive communication system for home care nursing assistance of peritoneal dialysis

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Abstract

Background: The Japanese population is aging quickly. New methods of supporting peritoneal dialysis (PD) for elderly patients are essential if we are to increase the number of such patients.

Methods: We established a two-way communication system between a central hospital and stations for visiting nurses. Home care nurses provided physicians at the central hospital with clinical findings for patients undergoing assisted PD. We compared 11 patients undergoing PD assisted by home care nurses in continuous interactive communication with the central hospital (cases) with 11 patients undergoing unassisted PD who were matched by sex, primary disease, estimated glomerular filtration rate at the start of PD, and age at the start of PD (controls). The variables compared were hospitalization due to heart failure, exit-site infection, peritonitis, and the composite of these causes during a 1-year period. In addition, we compared patient clinical factors between groups.

Results: Although differences in the number of hospitalizations attributable to exit-site infection, peritonitis, and heart failure were not significant, the difference in the number of hospitalizations attributable to a composite of these causes was significant. Exit-site scores were significantly better in the case group than in the control group.

Conclusions: PD assisted by home care nurses using an established continuous interactive communication system was associated with significantly better exit-site scores. Fewer cases than controls were hospitalized.

Keywords: Assisted peritoneal dialysis, Exit-site, Visiting nursing, Hospitalization

Background

The Japanese population is aging rapidly. The mean age is 70 years for dialysis patients [1] and 63 years for those on peritoneal dialysis (PD) [1]. Although the safety of PD is a concern for elderly patients, because of their lower physical activity and age-related cognitive deficits, some reports indicate that PD has been successful in this population [2, 3].

In Japan, only about 3% of patients requiring renal replacement therapy receive PD [1, 2]. To increase the number of

patients receiving PD, methods of ensuring its safety and effectiveness for Japanese elders must be developed. PD involves home medical care; thus, self-administered PD for elders with physical or cognitive problems presents challenges. Numerous studies of assisted PD—e.g., PD with the assistance of home care nurses or family members for non-self-sufficient patients undergoing PD—reported good clinical results in France, Denmark, and other countries [4–8]. In countries where assisted PD is available, the risk of peritonitis for elderly patients on PD has not increased [9]. Moreover, patients on automated PD assisted by a private nurse, but without regular home visits organized by the original training center, have a higher risk of peritonitis than do

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those on automated PD assisted by family members [10]. Taken together, these findings suggest that improvement in the quality of assisted PD, particularly with respect to the people providing PD assistance, could enhance outcomes for patients on PD.

Many of the PD patients we treat at our hospital are not self-sufficient and lack family support for PD; thus, we introduced assisted PD with a home care nurse. However, in our previous assisted PD system, our hospital provided written regular contact with home care nurse stations only once per month. Because this system did not adequately support patients on PD, we established a new interactive communication system that allows our hospital to communicate continuously with home care nurse stations using a more secure application in smartphone enough to send photographs securely than E-mail, thus improving the quality of assisted PD; currently, Sharesource®; Baxter Healthcare, is provided, and the system may improve the management for patients on PD, because medical staffs can check additional information of the therapy in patients on PD by the system more frequently. However, the system is for only patients on automated PD and does not include information by photograph. We had many patients undergoing not automated PD, and we also wanted information by photograph such as around exit-site.

To evaluate the effectiveness of this new interactive communication system for assisted PD at our hospital, we compared the number of hospitalizations attributable to exit-site infection, peritonitis, and heart failure, as well as clinical variables such as exit-site scoring, between patients on PD with home care nurse assistance and those on PD without nurse assistance [11, 12].

Methods

Establishment of a continuous interactive communication system

A two-way communication system was established between the central hospital (Nippon Medical School Hospital) and stations for visiting nurses; the usual

frequency of home care nurse visits was once a week. Physicians working at the central hospital were informed by home care nurses of physical findings and PD status using a more secure application in smartphone enough to send photographs securely than E-mail, including each treatment time of PD, ultrafiltration, and technical difficulties, and were provided with photographs of exit-sites of patients undergoing assisted PD. There was no additional financial cost using the secure application for doctors in center hospital and stations for visiting nurses because the application was free.

Figure 1 shows the previous and new communication systems in our hospital in this study.

Study design

This study was a single-center case-control study. All patients provided informed consent before study participation and were allowed to opt out. The present study protocol was approved by the Ethical Committee of Nippon Medical School Hospital (B-2020-233) and registered in the University Hospital Medical Information Network (UMIN No. 000038460). This study was designed and conducted in accordance with the principles of the Declaration of Helsinki.

Participants: cases and controls

The cases were 11 patients who received PD assisted by home care nurses and continuous interactive communication with the central hospital from April 2019; the controls were 11 patients receiving unassisted PD, who were matched by sex, primary disease, estimated glomerular filtration rate (eGFR) at the start of PD, and age at the start of PD. The controls were selected from patients who started PD at our hospital and attended our hospital regularly from April 2015 to March 2020. The variables compared were hospitalizations due to heart failure, exit-site infection, peritonitis, and the composite of these causes. In addition, we compared the following clinical factors between groups: sex, age, body mass index, diabetes,

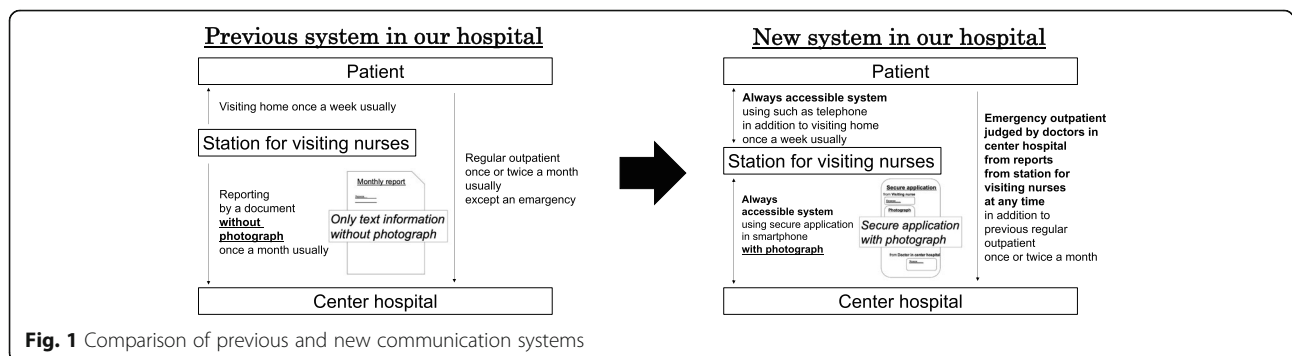


Fig. 1 Comparison of previous and new communication systems

hypertension, cardiovascular disease at initiation of PD, smoking status, automated PD, dialysate creatinine to plasma creatinine ratio (D/P Cr), dialysate glucose to initial dialysate glucose ratio (D/D0 Glu), use of renin-angiotensin system inhibitors, and diuretics, vitamin D supplementation, eGFR at the start of PD, hemoglobin (Hb), cardiothoracic ratio (CTR), N-terminal pro-brain natriuretic peptide (NT-proBNP), serum phosphorus (P), intact parathyroid hormone, serum potassium (K), serum creatinine (Cr), serum albumin, and exit-site score. Data on exit-site score and levels of serum K, serum P, CTR, NT-proBNP, and Hb were collected at regular monthly outpatient visits [11, 12].

Exit-site score estimates the status of the exit-site in patients on PD and is recommended by the International Society for Peritoneal Dialysis. It comprises five elements: swelling, crust, redness, pain, and drainage. Each element is scored from 0 to 2 points: a total score of 0 is best and 10 is worst [11, 12].

We compared hospitalizations and clinical factors between groups by using the log-rank test: we compared the number of hospitalizations attributable to exit-site infection, peritonitis, heart failure, and a composite of those three causes. We defined a hospitalization due to exit-site infection as a case of exit-site infection that required hospitalization for intravenous antibiotic therapy or surgical management for exit-site infection. A first hospitalization attributable to any of the three causes or their composite was defined as the endpoint in log-rank analysis of those hospitalizations. Two-way analysis of variance (ANOVA) was used to analyze differences in clinical factors.

The observation period in this study was the interval from the start of PD to the cessation of PD, for any cause, or the end of the study. The maximum observation period for a patient was 12 months.

Statistical analysis

All data are presented as mean \pm SD or median and range, as appropriate. A *P* value of less than 0.05 was considered to indicate statistical significance. Differences between groups were analyzed with the Student *t*-test or Wilcoxon rank-sum test. Categorical variables were compared between groups with the Fisher exact test. Cumulative probabilities of admission for the first episode of heart failure, peritonitis, and exit-site infection were calculated with the Kaplan-Meier method and log-rank test. Two-way ANOVA was performed on longitudinal data to address data multiplicity. All statistical analyses were done with Prism software, version 8 (GraphPad Software, La Jolla, CA, USA).

Results

Participants

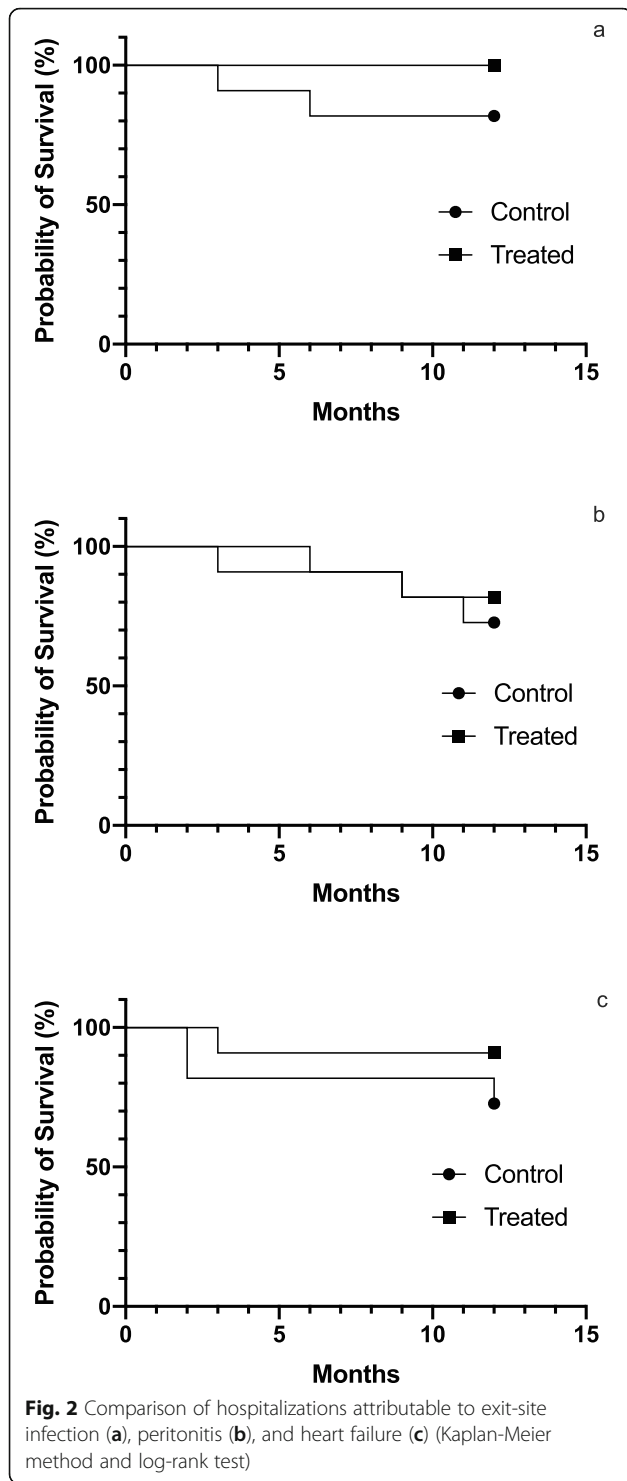
This study included 10 men and 12 women. Table 1 shows the baseline characteristics of the cases and controls. We matched the groups in relation to sex, primary disease, eGFR at the start of PD, and age at the start of PD; the average of Hb, Alb, and Cr was lower in the control group than the case group, but there were no significant differences in any variable. All participants used the automated connecting and disconnecting device with ultraviolet light undergoing PD. The number of patients undergoing automated PD was lower in the control group than the case group, but the difference between the two groups was not significant. There was no patient undergoing combination therapy with hemodialysis and PD.

Hospitalizations attributable to heart failure, exit-site infection, peritonitis, and their composite

The log-rank test showed that differences between groups in the number of hospitalizations attributable to exit-site infection (*p* = 0.15), peritonitis (*p* = 0.6668), and heart failure (*p* = 0.28) were not significant (Fig. 2a–c). The difference in the number of hospitalizations attributable to a composite of the causes was significant (*p* = 0.044), and fewer cases than controls were hospitalized (Fig. 3). All hospitalizations of cases resulted in satisfactory outcomes.

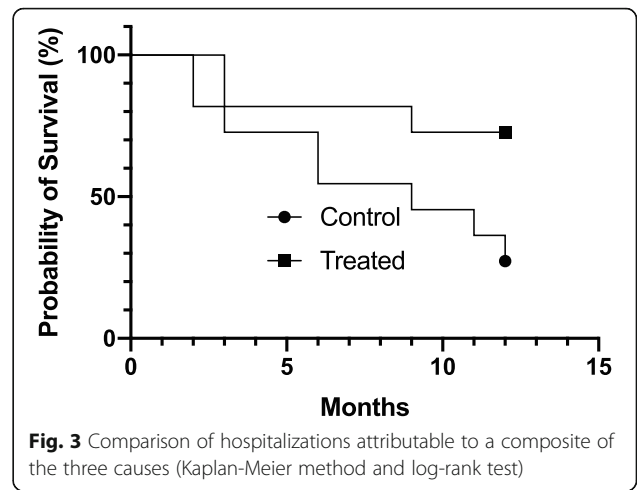
Table 1 Baseline clinical characteristics of cases and controls

No.	Cases	Controls	<i>P</i> value
	11	11	
Female (n)	6	6	> 0.9999
Age (years)	70.5 \pm 10.2	69.1 \pm 12.2	0.7792
Body mass index (kg/m ²)	22.97 \pm 4.45	24.41 \pm 3.25	0.3967
Diabetes (n)	6	6	> 0.9999
Hypertension (n)	10	11	> 0.9999
CVD (n)	5	5	> 0.9999
Smoking (n)	4	4	> 0.9999
RASi (n)	6	9	0.3615
Diuretic (n)	5	6	> 0.9999
Vit D supplement (n)	2	1	> 0.9999
Automated PD (n)	7	5	0.6699
eGFR (mL/min/1.73m ²)	6.82 \pm 3.10	6.68 \pm 2.37	0.9087
sCr (mg/dL)	7.09 \pm 3.01	6.65 \pm 2.14	0.6922
Alb (g/dL)	3.54 \pm 0.54	3.17 \pm 0.56	0.136
Hb (g/dL)	10.15 \pm 1.18	9.34 \pm 0.69	0.0612
Serum K (mEq/L)	4.57 \pm 0.67	4.67 \pm 0.49	0.6932
D/P Cr	0.60 \pm 0.16	0.70 \pm 0.10	0.1
D/D0 Glu	0.42 \pm 0.11	0.38 \pm 0.075	0.3282



Comparison of clinical variables

Exit-site scores were significantly better for the cases than for the controls ($p = 0.0032$) (Fig. 4 a). However, differences in serum phosphorous ($p = 0.067$), NT-proBNP ($p = 0.17$), CTR ($p = 0.3373$), serum potassium



($p = 0.24$), and Hb ($p = 0.16$) levels were not significant (Fig. 4b–f).

Discussion

PD is administered mainly by means of home medical care. This can be an advantage or disadvantage of PD, because non-self-sufficient elderly patients on PD require help from other people to receive PD at home. The International Society for Peritoneal Dialysis published the “International Society for Peritoneal Dialysis Practice Recommendations: Prescribing High-quality Goal-directed Peritoneal Dialysis” in 2020. The recommended aims of care were “(1) to allow the person doing PD to achieve his/her own life goals and (2) to promote the provision of high-quality dialysis care by the dialysis team” [13]. In January 2018, the Kidney Disease: Improving Global Outcomes (KDIGO) group convened a Controversies Conference, which concluded that a more comprehensive paradigm of end-stage renal disease care was necessary and that evaluation of dialysis adequacy should not be limited to small-solute clearance, such as Kt/V [14].

These recommendations indicate that achieving personalized and patient-specific goals is essential for successful PD. To meet these goals, comprehensive PD care should be adjusted to personal circumstances, including patients’ living environment and economic situation. For non-self-sufficient elders with end-stage renal disease who cannot manage PD themselves or self-administer PD at home, PD assisted by home care nurses or family members might be successful. Numerous studies, in France, Denmark, and other countries, have reported successful clinical outcomes [4–8]. Treatment satisfaction among elderly patients was greater for assisted PD than for hemodialysis, [15] and peritonitis risk was not higher in countries where assisted PD is available [9]. However, peritonitis risk for patients on assisted PD was

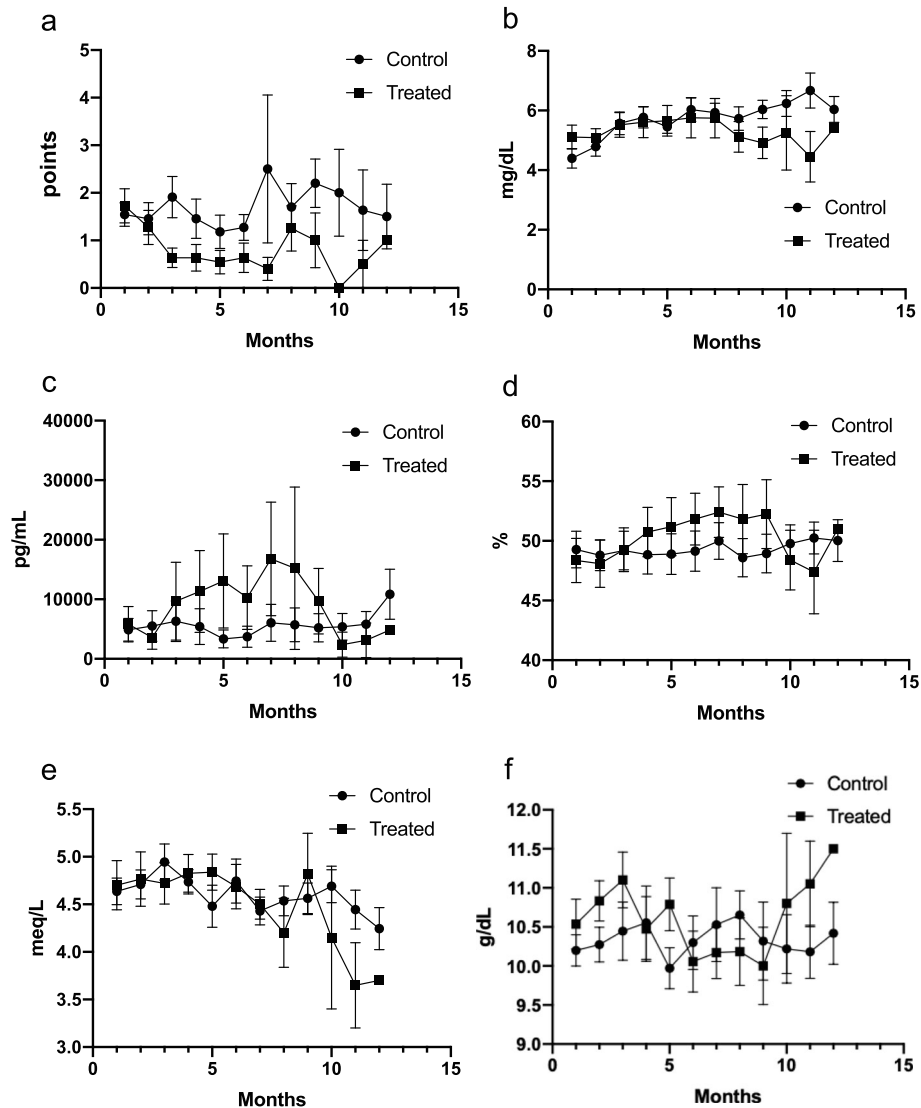


Fig. 4 Comparison of exit-site score (a), serum phosphorous (b), N-terminal pro-brain natriuretic peptide (c), cardiothoracic ratio (d), serum potassium (e), and hemoglobin (f) (analysis of variance [ANOVA])

higher for those with a private nurse only than for those with family members, unless additional regular home visits were organized by the original training center [10].

PD-related peritonitis, exit-site and tunnel infection, and heart failure due to ultrafiltration failure are common PD complications and important causes of PD drop-out [16–20]. Hyperphosphatemia is associated with mortality in patients on PD [21, 22], and hypokalemia is common and a risk factor for peritonitis in patients on PD [23, 24]. Patient diet affects both these factors.

Differences between cases and controls in the number of hospitalizations due to exit-site infection ($p = 0.15$), peritonitis ($p = 0.67$), and heart failure ($p = 0.28$) were not significant in this study. However, the cases had no hospitalizations due to exit-site infection. Therefore, this

new communication system for assisted PD may reduce hospitalizations due to exit-site infection. We noted one hospitalization due to peritonitis in the case group. Peritonitis was not associated with exit-site infection or technical failure and was considered endogenous. In contrast, there were three hospitalizations due to peritonitis in the control group, two of which were endogenous and without exit-site infection or technical failure. In this study, three of the five patients hospitalized for peritonitis (60%) were classified as having endogenous peritonitis. Therefore, our system for assisted PD may not be able to prevent endogenous peritonitis in patients on PD. Thus, a different system might be needed to decrease hospitalizations attributable to peritonitis in patients on PD.

The numbers of hospitalizations attributable to the three investigated causes did not significantly differ between groups, but the number of hospitalizations due to the composite of these causes was significantly lower among the cases. Although it is possible that limitations such as the short observation period (i.e., 1 year) and the small number of patients ($N = 22$) affected the results, our findings suggest that the new communication system reduces the number of hospitalizations due to complications in patients on PD.

Analysis of clinical factors showed that exit-site scores were significantly better in the case group than in the control group ($p = 0.0032$), perhaps because assisted PD with our new communication system aided in early detection and prevention of exit-site infections in patients on PD, as indicated by the absence of hospitalizations due to exit-site infection.

Other factors, e.g., hospitalizations due to heart failure and CTR, NT-proBNP, and Hb levels, did not significantly differ between cases and controls. This suggests that assisted PD did not control heart failure effectively in patients on PD. Serum potassium and phosphorus were not significantly affected by the daily diet of patients on PD. However, heart failure is affected by daily diet, particularly by salt and water intake. Administration of PD by home care nurses visiting only once a week may not be sufficient to improve these factors, although we did not conduct a comprehensive analysis of patients' daily diet in this study.

Limitations

This study has several limitations. First, it was conducted at a single center and the sample size was too small to allow robust statistical analysis. Second, the observation period was short. Third, because PD and assisted PD are medical treatments based on insurance coverage, and the matched patients in the control group were selected by clinical factors, patient selection was biased. Fourth, the cases did not all have the same home nurse. Fifth, there was no patient undergoing combination therapy with hemodialysis and PD in this study. In patients undergoing combination therapy, the patients need to visit the hospital once a week to undergo hemodialysis. Therefore, that might cause some biases in this study.

Conclusions

Our findings suggest that the introduction of PD assisted by home care nurses and a continuous interactive communication system improved exit-site status and the number of hospitalizations caused by complications of PD in patients undergoing PD.

Abbreviations

CVD: Cardiovascular disease; Smoking: Current/former smoking; Vit D: Vitamin D; eGFR: Estimated glomerular filtration rate; sCr: Serum creatinine;

Alb: Serum albumin; Hb: Hemoglobin; K: Potassium; D/P Cr: Dialysate creatinine to plasma creatinine ratio; D/D0 Glu: Dialysate glucose to initial dialysate glucose ratio; PD: Peritoneal dialysis

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Authors' contributions

KT drafted the first manuscript. KT, YY, TY, TF, AH, TK and YS managed the patient. YS coordinated the data analysis and helped with writing the manuscript. All authors participated in discussions and read and approved the final manuscript.

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Availability of data and materials

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

The present study protocol was approved by the Ethical Committee of Nippon Medical School Hospital (B-2020-233) and registered in the University Hospital Medical Information Network (UMIN No. 000038460).

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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