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Original Article

A Multidisciplinary Approach to Hip Fractures: Evaluating Outcomes on Mortality and Secondary Hip Fractures

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Fracture liaison services (FLS) have been introduced in Japan and several other countries to reduce medical complications and secondary fractures. We aimed to evaluate the effects of the implementation of an FLS approach on patient outcomes during hospitalization at our hospital and over a 2-year follow-up post-injury. This retrospective cohort study included patients ≥ 60 years admitted to our hospital for hip fragility fractures between October 1, 2016, and July 31, 2020. Patient groups were defined as those treated before (control group, n = 238) and after (FLS group, n = 196) establishment of the FLS protocol at our institution. The two groups were compared in terms of time to surgery, length of hospital stay, and the incidence of complications after admission, including secondary hip fracture and mortality rates. The follow-up period was 24 months. FLS focuses on early surgery within 48 h of injury and assessing osteoporosis treatment before injury to guide post-discharge anti-osteoporosis medication. FLS reduced the length of hospital stay ($p < 0.001$) and the prevalence of complications after admission ($p < 0.001$), particularly cardiovascular disease, and it increased adherence to anti-osteoporosis medication. These FLS effects resulted in lower secondary hip fracture and mortality rates at 12 and 24 months post-injury. FLS for fragility hip fractures can improve patient outcomes during hospitalization and over a 2-year follow-up period.

Key words: fracture liaison services, complications after admission, secondary hip fracture, mortality

The incidence of hip fragility fractures has been increasing in Japan due to the continuous growth in the elderly population [1]. Takusari *et al.* reported 175,700 new hip fractures in Japan in 2012, which increased to 193,400 in 2017, representing a 5-year increase of 10% [1]. In 2015, the mean age of individuals sustaining a hip fracture in Niigata Prefecture, Japan, was 81.4 and 84.9 years for males and females, respectively, with 80% of patients having two or more comorbidities [2]. Furthermore, 20-25% of patients who sustained a hip fracture developed medical complications after hospital admission [3, 4]. The occurrence of complications after admission can delay the progression of rehabilitation, limit activities, and increase the risk of patients becoming bedridden and dying. Therefore, a comprehensive approach to the treatment of hip fractures that limits postoperative complications is needed.

Different models of fracture liaison services (FLS) introduced in the United Kingdom [5-10] and Japan [4, 11] have been shown to effectively reduce the rate of

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medical complications and secondary fractures, with overall cost savings in hip fracture treatment [12-14]. However, only limited data exist on hip fracture outcomes after the introduction of FLS in Japan. In the early fall of 2018 our hospital introduced a multidisciplinary FLS based on the model implemented in Toyama Prefecture [11]. Therefore, this study sought to examine the effects of the implementation of this FLS approach on the time to surgery, length of hospital stay, and incidence of medical complications after admission at our hospital, as well as secondary hip fracture and mortality rates.

Materials and Methods

Statement of ethics, study design, and selection of the study sample. The study was conducted in accordance with the principles of the Declaration of Helsinki (1964) and was approved by the Institutional Review Board of Niigata Prefectural Tokamachi Hospital (Approval No.: 4-4). Additionally, the requirement for written informed consent was waived due to the cohort study's retrospective design. Only the identified researchers had administrative authority over this study and access to the patient data. Further, patients could "opt out" from the study after reading about the study design, objectives, and opt-out instructions on our home page.

The study sample was identified from the database of our hospital. Patients aged ≥60 years who sustained a hip fragility fracture, including femoral neck or trochanteric fractures, between October 1, 2016, and July 31, 2020 were eligible. Patients with pathological periprosthetic fractures and those who had sustained high-energy injuries (*e.g.*, traffic accidents) and falls from heights were excluded. Patients enrolled in this study were assigned to two groups based on the date of injury as follows: a control group (n = 301 patients) whose injuries occurred between October 1, 2016, and August 31, 2018, before the implementation of the FLS protocol, and an FLS group (n = 245) whose injuries occurred between October 1, 2018, and July 31, 2020, after the implementation of FLS. As in our previous report [4], we excluded patients who were lost during follow-up at < 3 months after their injury. The final analysis included 238 and 196 patients in the control and FLS groups, respectively (Fig. 1).

The FLS model at our hospital. The structure of

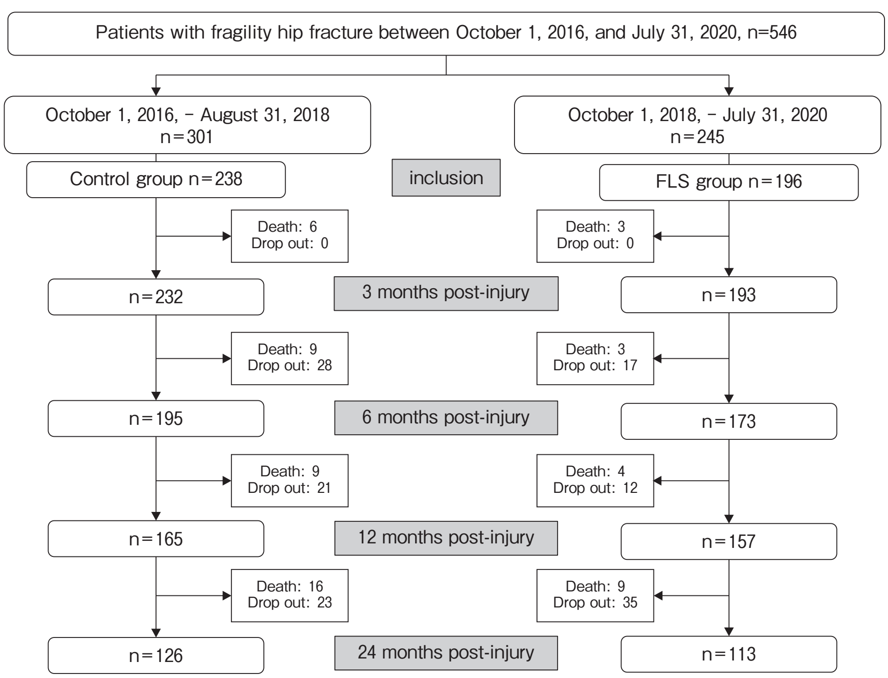

Fig. 1 Flow diagram of patients included in the control and FLS groups, including the number of patients available for analysis at each time point of the study.
FLS, fracture liaison service.

the FLS implemented at our hospital is shown in Fig. 2, including direct and indirect reporting lines with the treating orthopedic surgeon. To reduce the burden of consultation, a dedicated internist ensured coordination between the orthopedic surgeon and each medical specialty. As recommended by several hip fracture management guidelines, the goal was early surgery within 48 h after injury, with specialists providing their input on the patient's status for early surgery [15,16]. Once a patient was deemed suitable for surgery, the anesthesiologist arranged for prompt performance of the surgery. Our anesthesiologists have specialized training in both anesthesiology and internal medicine; *i.e.*, they have sufficient knowledge and skills in perioperative systemic management. Therefore the same person can quickly coordinate the entire process from admission to surgery, enabling early surgery.

Within our FLS, the pharmacist evaluated a patient's osteoporosis treatment status before the injury and informed the nurse on the unit and the treating orthopedic surgeon as to whether osteoporosis medications should be prescribed before discharge to prevent secondary fractures. The treating orthopedic surgeon prescribed the appropriate anti-osteoporosis treatment, such as bisphosphonates, following the pharmacist's recommendation.

The physical therapist was responsible for postoperative rehabilitation, including gait training and return to independence in activities of daily living. Additionally, the physical therapist performed a home visit before discharge to verify a patient's living environment and recommend adaptations as needed. The nurses on the unit liaised with the pharmacist and physical therapist to provide patient support for discharge. Lastly, before discharge, the dentist on the FLS team assessed the patients' oral condition to prevent osteonecrosis of the jaw.

Data extraction. The following data were extracted from patients' medical records, with the flow of the analysis and time points shown in Table 1. Patient information included sex; age (years); delay from the time of injury to surgery (days), from which the rate (percent) of surgery within 48 h of injury was calculated; and the mean length of hospital stay (days). Comorbidity types at the time of surgery were classified as previously described: *i.e.*, hypertension, cardiovascular disease, pulmonary disease, renal disease, urinary tract infection, diabetes, cerebrovascular disease, and digestive disease [3,4]. Complications after admission were also recorded, namely worsening of comor-

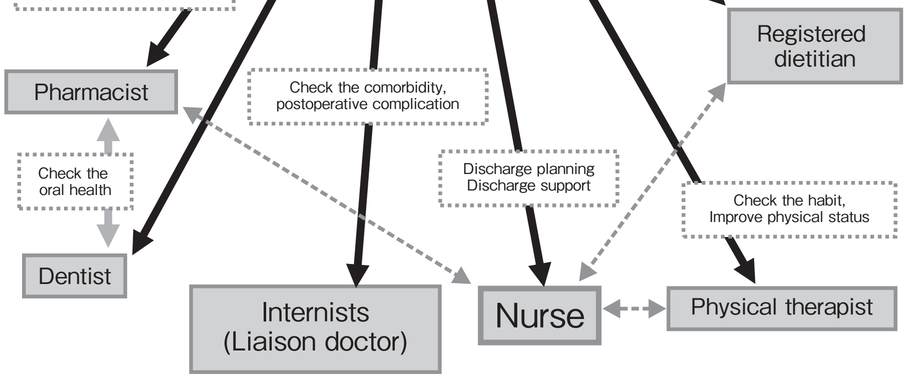

Fig. 2 Fracture liaison service team, including roles for each department and direct and indirect reporting to the treating orthopedic surgeon.

Table 1 Characteristics of the study sample

	Control Group	FLS Group	*P*-value
Survey period	2016.10.1 to 2018.8.31	2018.10.1 to 2020.7.31	
Participants	301	245	
Included	238	196	
Sex, M : F	57: 181 (Females: 76.1%)	41: 155 (Females: 79.1%)	0.452[b]
Age, mean ± SD (years)	87.1 ± 9.3	86.8 ± 8.5	0.715[a]
Delay from injury to surgery, mean ± SD (days)	2.18 ± 2.65	1.83 ± 2.25	0.145[a]
Proportion of surgeries performed within 48 h post-injury	145/220 (65.9%)	138/190 (72.6%)	0.142[b]
Length of hospital stay, mean ± SD (days)	47.6 ± 23.0	43.0 ± 18.6	0.025[a]
Comorbidities at the time of injury			
n[#] (%)	206/238 (86.5%)	175/196 (89.3%)	0.387[b]
Hypertension	129/238 (54.2%)	125/196 (63.8%)	0.069[b]
Cardiovascular disease	59/238 (24.8%)	40/196 (20.4%)	0.279[b]
Pulmonary disease	28/238 (11.8%)	18/196 (9.2%)	0.385[b]
Renal disease	26/238 (10.9%)	14/196 (7.1%)	0.175[b]
Diabetes	29/238 (12.2%)	32/196 (16.3%)	0.233[b]
Cerebrovascular disease	37/238 (15.5%)	34/196 (17.3%)	0.614[b]
Digestive disease	35/238 (14.7%)	41/196 (20.9%)	0.090[b]
Complications after admission			
n[#] (%)	89/238 (37.4%)	41/196 (20.9%)	<0.001[b]
Cardiovascular disease	18/238 (7.6%)	6/196 (3.1%)	0.036[b]
Pulmonary disease	20/238 (8.4%)	9/196 (4.6%)	0.114[b]
Renal disease	21/238 (8.8%)	12/196 (6.1%)	0.290[b]
Urinary tract infection	6/238 (2.5%)	2/196 (1.0%)	0.247[b]
Cerebrovascular disease	6/238 (2.5%)	7/196 (3.6%)	0.523[b]
Digestive disease	23/238 (9.7%)	13/196 (6.6%)	0.254[b]
Rate of adherence to anti-osteoporosis medication			
At the time of injury	38/238 (16.0%)	33/196 (16.8%)	0.807[b]
3 months post-injury	71/232 (30.6%)	158/193 (81.9%)	<0.001[b]
6 months post-injury	66/195 (33.8%)	143/173 (82.7%)	<0.001[b]
12 months post-injury	65/165 (39.4%)	127/157 (80.9%)	<0.001[b]
24 months post-injury	62/133 (46.6%)	105/130 (80.8%)	<0.001[b]
Rate of anti-osteoporosis medication adherence overall	52/126 (41.3%)	99/113 (79.6%)	<0.001[b]

[#], number including duplicate cases; [a], Student's *t*-test; [b], Fisher's exact test.
FLS, fracture liaison service.

bidities and any secondary (contralateral) hip fractures sustained within 12 and 24 months after the initial hip fracture. The adherence rate to anti-osteoporotic medications was also calculated and adjusted for the number of patients lost during follow-up and who had died at each time point. Complications after admission and medication adherence were evaluated at 3, 6, 12, 18, and 24 months post-injury. Mortality was evaluated at 1, 12, and 24 months post-injury.

Statistical analysis. The Kolmogorov–Smirnov test was used to assess the normally distributed continuous variables. Fisher's exact test was used for between-group comparisons of categorical data, with an unpaired Student's *t*-test for continuous data. Kaplan–Meier analysis and log-rank tests were used to evaluate the incidence of secondary hip fractures and the mortality rates at 12 and 24 months post-injury. Post hoc analyses were performed to assess the statistical power (type II [beta] error). For *t*-tests, the effect size (d) and type I (alpha) error were set at 0.5 and 0.05, respectively. For Fisher's exact test, (d) was set to 0.3 and type I (alpha) error to 0.05. For all analyses, results were considered statistically significant with two-tailed p-values < 0.05. All statistical analyses were performed using IBM SPSS

Statistics for Windows, version 28 (IBM Corp., Armonk, NY, USA).

Results

Table 1 and Fig. 3 and 4 present the characteristics of the study sample and the differences in outcomes between groups. The following outcomes were better in the FLS than in the control group: reduction in length of hospital stay (47.6 days versus 43.0 days for the control and FLS groups, respectively; $p = 0.025$); lower overall occurrence of complications after admission ($p < 0.001$); lower occurrence of cardiovascular disease after admission ($p = 0.036$), although the rate of particular comorbidities those we previously described was not different between the two groups at the time of injury; a higher adherence rate to anti-osteoporotic medication throughout the follow-up period ($p < 0.001$), although this was not different between the two groups at the time of injury; higher overall adherence rate to anti-osteoporotic medication ($p < 0.001$); lower rate of secondary hip fractures at 24 months but not 12 months (Fig. 3); and lower mortality rates at 12 and 24 months (Fig. 4). The delay from injury to surgery was lower for the FLS group (1.83 days) than for the control (2.18 days) group although this difference was not significant; namely, patients in the FLS group tended to undergo surgery within 48 h of injury at a higher proportion than in the control group. Post hoc analyses revealed a power of 0.999 for both t-tests and Fisher's exact test.

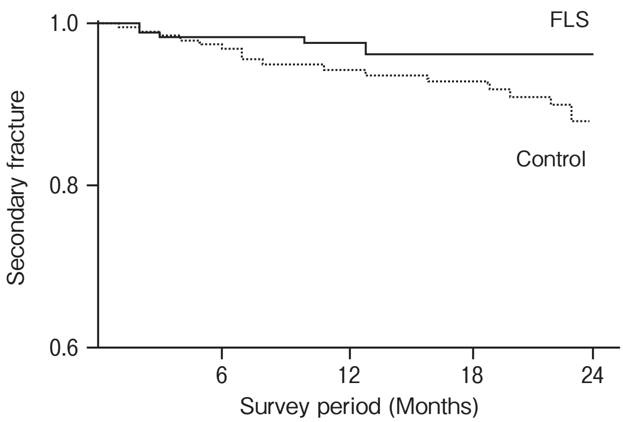

Fig. 3 Comparison in the rate of contralateral hip fracture using Kaplan–Meier survival estimates. The rate was slightly lower for the FLS group than for the control group at 12 and 24 months post-injury.
FLS, fracture liaison service.

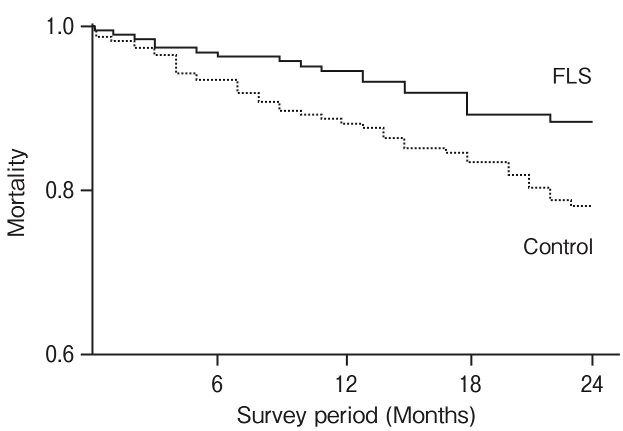

Fig. 4 Comparison of mortality rates using Kaplan–Meier survival estimates. The rate was slightly but not significantly lower for the FLS than the control group at 12 and 24 months post-injury.
FLS, fracture liaison service.

Discussion

Our findings confirmed a significant reduction in the rate of complications after admission for the FLS group compared to the control group. This result may be due to more rapid surgical and medical interventions for complications at the time of injury, which reduced the occurrence of new complications after admission and prevented the worsening of existing complications. Previous studies have reported similar results [4, 11, 17-19]. We believe that early intervention by the team internist resulted in the prompt approval and scheduling of the surgery and that the internist intervened before the patient's general condition and hemodynamics deteriorated, possibly reducing the occurrence of some complications. As noted in the literature, we believe that internists contribute to improved systemic management, including postoperative cardiovascular management [20, 21]. Additionally, collaboration with anesthesiologists further resulted in a shorter duration from injury to surgery. The length of the hospital stay was effectively decreased in the FLS group compared to the control group, which is consistent with findings from a previous report [22]. The ability to perform surgery early led to fewer complications, resulting in shorter hospital stays.

In this study, both the FLS and control groups had hospital stays of ≥40 days in average. Hagino *et al.* reported that the mean hospital stay for proximal femur fracture in Japan is approximately 40 days [23]. A previous study reported that the mean length of stay in acute care hospitals alone was approximately 20 days [4]; therefore, the mean length of stay in our hospital was not excessive, and this study's results could be considered valid. The decrease in length of stay and the reduction in complications after admission may be cost-effective to the patient and the hospital, although we did not evaluate cost specifically in our study [24].

Since most of the inpatient deaths were due to postoperative complications of cardiac disease and sepsis, the significant reduction in postoperative cardiac complications in the FLS group in this study contributed to the lower mortality rate in this group [21]. More broadly, the lower mortality in the FLS group may reflect the intensive medical care provided by our well-organized FLS multidisciplinary team, quicker surgery and progression in rehabilitation, and higher adherence to osteoporosis medication. Lastly, an important outcome was the reduction in contralateral hip fractures within 2 years of the initial hip fracture in the FLS group compared to the control group. Although previous studies did not report a reduction in the rate of recurrent hip fractures with FLS-based care, they did report a reduction in the risk of recurrent fragility fractures, including hip fractures [4,25]. Achieving success in secondary fracture prevention is associated with high osteoporosis medication adherence. The entire FLS team educated patients on the importance of osteoporosis treatment for secondary fracture prevention through community study groups conducted both within and outside the hospital, aiming to increase the rate of osteoporosis medication adherence for the behavior of starting to take the drug and continuing to take the drug. Before discharge, the attending physicians, ward nurses, and pharmacists triple-checked for any omissions in the prescriptions of osteoporosis drugs. Each attending physician also reconfirmed at 3, 6, 12, 18, and 24 months post-discharge whether the prescription was being continued through the outpatient clinic. To ensure that prescriptions could be continued seamlessly at other hospitals, we checked the osteoporosis medications used at all hospitals in the region and focused on prescribing those that could be continued elsewhere.

Limitations. Our study had some limitations that should be acknowledged when applying our findings to clinical practice. First, this study was conducted in a single center and was not randomized. Second, the sample size was relatively small, with 238 and 196 patients in the control and FLS groups, respectively, and only approximately 60% of patients completing the follow-up. Third, because of the retrospective design, causation between the FLS-based care and measured outcomes could not be attributed. Therefore, future prospective studies are needed to provide high-quality evidence on the effects of FLS-based care. Fourth, although our centrally located hospital admits patients from a wide area, those patients are transferred to inpatient rehabilitation facilities closer to their residences. Lastly, we did not assess the physical status of patients after injury, which may have influenced the instances of patients becoming bedridden and the mortality rates. Therefore, future studies should include physical status as an explanatory variable to provide a more robust evaluation of FLS-based care outcomes.

In conclusion, we identified shorter times to surgery, better post-discharge outcomes, including lower rates of complications and mortality, increased adherence to anti-osteoporosis medication, and lower rates of secondary fractures as benefits of FLS-based care. These advantages should help patients with fragility hip fractures return to routine activities and enjoy a longer and higher quality of life. In the future, prospective studies will be needed to obtain high-quality evidence to support FLS-based care and to compare outcomes for different models of FLS-based care.

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