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Original Article

Effects of hospitalist co-management on rate of initiation of osteoporosis treatment in patients with vertebral compression fractures: Retrospective cohort study☆

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ABSTRACT

Background: Vertebral compression fractures are common in elderly people and most are due to osteoporosis. Osteoporosis treatment is effective for secondary prophylaxis, so initiation is recommended. Despite the clear benefits, the rate of initiation of osteoporosis treatment is very low. It is reported to be due to several factors including insufficient systems-based approaches for hospitals and post-acute care. Hospitalists, who are physicians dedicated to the treatment of patients in hospital and whose activity is generalist rather than specialized, are reported to be associated with higher-quality inpatient care because of, among other things, closer adherence to guidelines. Co-management by hospitalists for patients with vertebral compression fractures has potential benefits towards improving the outcomes. We compared the rate of initiation of osteoporosis treatment for patients with vertebral compression fractures between conventional orthopedic surgeon-led care (conventional group) and hospitalist co-management care (co-management group).

Methods: This is a single-center retrospective cohort study to evaluate the rate of initiation of osteoporosis treatment and reasons for non-initiation of osteoporosis treatment. Other clinical indicators were also evaluated, including length of hospital stay, preventable complications during hospitalization, and rate of 30-day readmission.

Results: We identified 55 patients in the conventional group and 93 patients in the co-management group. The rate of initiation of osteoporosis treatment was higher in the co-management group (45.2% vs. 3.6%, OR 21.5; 95%CI 5.12–192.0; $P < 0.01$). Most of the patients with non-initiation in the co-management group had reasons for it described in the medical records, but in the conventional group the reasons were unknown. There was no significant difference in length of hospital stay, preventable complications during hospitalization, or 30-day readmission between the groups.

Conclusions: Hospitalist co-management of patients with vertebral compression fractures showed significantly higher rate of initiation of osteoporosis treatment than conventional orthopedic surgeon-led care.

1. Introduction

Vertebral compression fractures (VCFs) are one of the most common orthopedic fractures in elderly people [1]. Most of the fractures are caused by osteoporosis, and if osteoporosis is not managed appropriately, 19% of patients will have further fractures within a year [2]. Osteoporosis medications reportedly reduce refracture by 50% [3–5], so it is recommended that patients with

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VCFs should be treated with them [6]. The rate of initiation of new osteoporosis treatment, however, has been reported to be low [7]. The low rate of initiation could be attributed to several factors such as lack of motivation, misconceptions about osteoporosis treatment, lack of perceived benefits of therapy, and insufficient systems-based approaches for hospitals and post-acute care. It is likely that novel strategies will be needed to increase the rate [8].

Hospitalist intervention could potentially solve or alleviate this issue. Hospitalists have a well-established presence in hospital medicine in the United States. They are defined as physicians who focus primarily on hospital medicine. They provide medical care on the wards, bridging the gap between specialists and transfer of care to PCPs. Hospitalists are reported to be associated with higher-quality inpatient care because of close adherence to guidelines [9,10], and hospitalist co-management has been reported to improve the rate of initiation of osteoporosis treatment in patients with hip fractures [11]. The effect of hospitalist co-management for patients with VCFs, however, is uncertain.

Our general internal medicine (GIM) department is staffed by hospitalists, who provide inpatient care in accordance with a competency framework published by the Society of Hospital Medicine and with guidelines on hospital medicine from the United States, and the department includes a Japanese physician who was trained under the system used there. Patients with VCFs were previously always admitted to the Department of Orthopedic Surgery, but beginning in January 2019 our institution began hospitalist co-management. In this study, we retrospectively investigate the impact on rate of initiation of osteoporosis treatment for patients with VCFs by hospitalist co-management compared with conventional orthopedic surgeon-led care.

2. Materials and methods

2.1. Study design

This is a retrospective observational study conducted between January 2017 and December 2020 at Takatsuki General Hospital, a private urban acute care hospital in Japan. Patients who visited orthopedic, general practice or emergency outpatient department with low back pain or difficulty moving were evaluated for VCF if indicated. Patients with VCFs who met at least one of the following criteria were indicated for admission to our hospital: inability to walk, pain uncontrollable by oral analgesics, insufficient domestic or social support, and severe exacerbation of comorbidities that could not be treated as an outpatient. The majority of patients with VCFs were admitted to the Department of Orthopedic Surgery while others were admitted to various other departments until December 2018, and the orthopedic surgeons solely provided care for patients who were admitted to the Department of Orthopedic Surgery with consultations with other specialists when deemed necessary, this is typical of general practice in Japan. From January 2019, patients with VCFs with no indication of surgery were admitted to the GIM department, where hospitalist co-management was provided. The roles of the orthopedic surgeons and hospitalists in the co-management group and detailed protocol are shown in Tables 1 and 2, respectively. Especially in the co-management group, comprehensive geriatric assessment including cognitive function was performed and adherence to osteoporosis treatment was evaluated based on the results.

2.1.1. Participants

We retrospectively enrolled patients aged ≥65 years with principal diagnosis of VCF who were admitted to the Department of Orthopedic Surgery between January 2017 and December 2018, or who were admitted to GIM department between January 2019 and December 2020. Excluded were patients requiring surgical procedures for VCFs, those with osteoporosis treatment at admission, and those with fractures during hospitalization. Patients admitted to the Department of Orthopedic Surgery were identified as the conventional group, and patients admitted to GIM department were identified as the co-management group. Patient demographics and clinical characteristics are presented in Table 3, including age, gender, body mass index (BMI), estimated glomerular filtration rate (eGFR) at admission, Charlson comorbidity index (CCI), Barthel index, residence, type of long-term care insurance, type of hospital transportation and discharge destination. We evaluated the rate of osteoporosis treatment and the reason for non-initiation during hospitalization. Also evaluated were length of hospital stay (LOS), preventable complications during hospitalization, and 30-day readmission, which could be extracted from medical records retrospectively and which can be used to assess the quality of care. CCI was calculated using Quan's protocol [12]. We defined treatment for osteoporosis as bisphosphonates, anti-receptor activator of NFκB Ligand (RANKL) antibody (denosumab), human parathyroid hormone (teriparatide), and humanized anti-sclerostin monoclonal antibody (romosozumab) [13,14]. Calcium and Vitamin D alone were not considered as sufficient treatment for osteoporosis in this study. Complications during hospitalization were defined as pneumonia, urinary tract infections, *Clostridium difficile* enteritis, catheter-related and other infections, delirium, decubitus, deep venous thrombosis (DVT), falls, gastrointestinal bleeding and death, which are known hazards of hospitalization of elderly people [15]. Infections were defined as those in which antibiotics were used during hospitalization and were listed in the physician's records. Delirium was defined as the need for psychiatric intervention or the use of antipsychotic agents during hospitalization. DVT was defined as a complication listed as DVT or pulmonary embolism. Falls were extracted from incident reports. Gastrointestinal bleeding was defined as bleeding confirmed by upper gastrointestinal endoscopy. The medical records of each patient with complications were reviewed by two nurse practitioners using strategies for preventing complications (Supplementary 1), who did not take direct care of the patients. Complications were assessed using a questionnaire including three questions focused on the appropriateness of physician's practice: (1) Did the physician take sufficient precautions against complications? (2) Were there any reasons why the precautions could not be sufficiently taken? (3) Were any complications preventable? We counted the incidence of complications which were evaluated to be preventable by both of the two nurse practitioners.

2.2. Statistical analysis

Sample size was difficult to set due to the lack of previous studies. Continuous data was reported as median plus interquartile range (IQR) and analyzed by Mann−Whitney test. Categorical variables were presented as percentages, and the Chi-square test or Fisher's exact tests were used for analysis. A two-sided $P < 0.05$ was considered to be statistically significant. All analyses were performed using EZR version 1.38. (Saitama Medical Center, Jichi Medical University, Japan) [16].

2.3. Ethics

This research has been approved by the Institutional Review Board of the authors' affiliated institutions, and all activities were carried out in accordance with the principles of the Declaration of Helsinki. Informed consent was obtained in the form of opt-out on the hospital website.

Table 1
The role of the orthopedic surgeons and hospitalists in the co-management group.

	Orthopedic surgeon	Hospitalist
At admission		
Obtaining patient information (e.g., medical history)		○
Physical examination	Examination of vertebral compression fractures	General examination
Image evaluation	○	
Instruction of rest	○	
Cast prescription	○	
Explanation of medical condition to patient and the family	○	○
Entry of medical record	Related to vertebral compression fractures	Hospitalization summary
Paperwork required for hospitalization		○
Ordering rehabilitation		○
Entry order set (e.g., meals, instructions)		○
After hospitalization		
Daily physical examination		○
Daily medical record		○
Prescription, and management of complications and comorbidities		○ (Table 2)
Routine image evaluation	○	
Multidisciplinary team conference		○
Management of discharge		○
Explanation of medical condition to patient and their family		○
At discharge		
Paperwork required for discharge		○
Preparation of forms of patient information for discharge destination and PCP		○
Prescription for discharge		○
Completing discharge summary		○

PCP: primary care physician.

Table 2
Detailed protocol in the co-management group.

Pain control	
Pain assessment	Every day
Prescription of analgesics	Acetaminophen: use as first choice if no contraindications NSAIDs: use with caution in patients with inadequate control with acetaminophen and eGFR>30 mL/min/1.73㎡ Tramadol: use with caution in case of inadequate control with acetaminophen and difficulty with NSAIDs Transfer the necessity of reducing or discontinuing the medication to the physician who take care of the patient after discharge
Management of complications and comorbidities	
	At the attending physician's discretion
Prophylaxis of complications	
DVT prophylaxis	Patients with high Padua prediction score and without anticoagulant drugs: pharmacological prophylaxis if no contraindications If there are contraindications: mechanical prophylaxis
Delirium prophylaxis	Consideration of cessation or reduction of drugs which are linked to delirium Removal of unnecessary devices
Prophylaxis of nosocomial infections	Early removal of urinary catheters/IV route Aspiration prevention (oral care, intervention by speech therapist, avoidance of antacids if not indicated)
Preventing falls	Reduce or stop medications which are linked to falls when possible Removal of unnecessary devices Instructions for use of alarms and restraints as needed
Preventing gastrointestinal bleeding	Prescribe antacids if at least one of the following is met: coagulation abnormalities, platelet count <50 000/μL, history of gastrointestinal ulcer, antiplatelet drug use, anticoagulant drug use, corticosteroid use, SSRI use
Preventing decubitus	If oral intake is low, try to find the cause and increase energy intake
Prophylaxis of refracture (Based on CDC guidelines [27])	
Patient education	Guidance on quitting smoking and excessive drinking
Nutrition	Evaluate calorie, calcium and vitamin D intake and consultation with dietitian for dietary guidance Prescribe vitamin D if intake is insufficient
Management of comorbidites that increase fall risk	Management of chronic disease which is linked to falls, such as cognitive dysfunction and neurological, cardiovascular and musculoskeletal conditions
Interventions to home hazards	Improve footwear and home environment
Osteoporosis assessment	Bone mineral density testing
Osteoporosis medication	Prescribe bisphosphonate with consideration of medication compliance. If not possible, prescribe denosumab. If there is a reason why initiating osteoporosis medication was difficult, transfer the information to the physicians who take care of the patient after discharge.
Orthostatic hypotension	If recognized, establish the cause
Assess visual impairment	If the patient cannot read more than a newspaper headline, refer to an ophthalmologist
Management of medications that increase fall risk	Review prescription drugs and reduce or stop medications which are linked to falls when possible

CDC: Centers for Disease Control and Prevention, SSRI: Selective Serotonin Reuptake Inhibitor, Medications linked to falls: anticonvulsants, benzodiazepines, antidepressants, opioids, antipsychotics, sedative-hypnotics, anticholinergics, medications affecting blood pressure, antihistamines, muscle relaxants.

Table 3
Patients demographic and clinical characteristics.

	Conventional group (n = 55)	Co-management group (n = 93)
Age (years), median (IQR)	83 (80–87)	85 (77–87)
Female, n (%)	36 (65.5)	60 (64.5)
BMI, median (IQR)	21.0 (19.9–23.8)	20.9 (18.9–23.8)
eGFR (mL/min/1.73㎡) at admission, median (IQR)	57.9 (45.4–71.2)	55.5 (45.0–68.0)
CCI, n (%)		
0	18 (32.7)	23 (24.7)
1	24 (43.6)	34 (36.6)
2	9 (16.4)	13 (14.0)
3	4 (7.3)	22 (23.7)
4	0 (0.0)	1 (1.1)
Barthel Index at admission, median (IQR)	5 (0–46)	5 (0–25)
Living alone, n (%)	41 (74.5)	72 (77.4)
Residence, n (%)		
Home	55 (100.0)	85 (91.4)
Nursing home	0 (0.0)	6 (6.5)
Hospital	0 (0.0)	2 (2.2)
Long-term care insurance category, n (%)		
No usage of long-term care insurance	30 (54.5)	37 (39.8)
Requiring support 1	6 (10.9)	5 (5.4)
Requiring support 2	6 (10.9)	11 (11.8)
Requiring long-term care 1	4 (7.3)	12 (12.9)
Requiring long-term care 2	4 (7.3)	18 (19.4)
Requiring long-term care 3	5 (9.1)	8 (8.6)
Requiring long-term care 4	0 (0.0)	2 (2.2)
Emergency transportation to hospital, n (%)	40 (72.7)	72 (77.4)
Barthel Index at discharge, median (IQR)	58 (13–100)	20 (0–60)
Discharge destination, n (%)		
Home	21 (38.2)	13 (14.0)
Nursing home	4 (7.3)	9 (9.7)
Hospital	30 (54.5)	69 (74.2)
Death	0 (0.0)	2 (2.2)

CCI: Charlson comorbidity index.
There were statistically significant differences in Barthel Index at discharge and discharge destination.

3. Results

Seventy-one patients were initially considered in the conventional group, 16 of whom were excluded, so 55 patients remained for analysis. In the co-management group, 119 patients were initially considered, 26 of whom were excluded, so 93 patients remained for analysis. Fig. 1 shows further information on inclusion and exclusion. There were no missing data. Median age was not significantly different: 83 years in the conventional group and 85 years in the co-management group. Both groups had a majority of female patients. There were no statistically significant differences in BMI, eGFR or Barthel Index at admission. CCI, however, tended to be higher for patients in the co-management group. In the conventional group, all patients were admitted from home. In the co-management group, however, there were patients from nursing homes and hospitals, and patients tended to require higher nursing care level at the time of admission. At discharge, activity of daily living (ADL) was significantly higher, and more patients were discharged home in the conventional group (38.2% vs. 14.0%, $P = 0.005$).

The rate of initiation of osteoporosis treatment was 2 out of 55 (3.6%) in the conventional group, and 42 out of 93 (45.2%) in the co-management group (OR 21.5; 95%CI 5.12–192.0; $P < 0.01$) (Table 4). In the conventional group, the reason for non-initiation of osteoporosis treatment during hospitalization was unknown because it was not described in medical records, while Table 5 shows the reasons in the co-management group. The median LOS was not significantly different between the two groups: 15.5 days in the conventional group, and 16.0 days in the co-management group ($P = 0.522$). The rates of preventable complications and 30-day readmission were lower in the co-management group, without significant difference (1.1% vs. 3.6%, $P = 0.556$, 3.2% vs. 5.5%, $P = 0.671$, respectively).

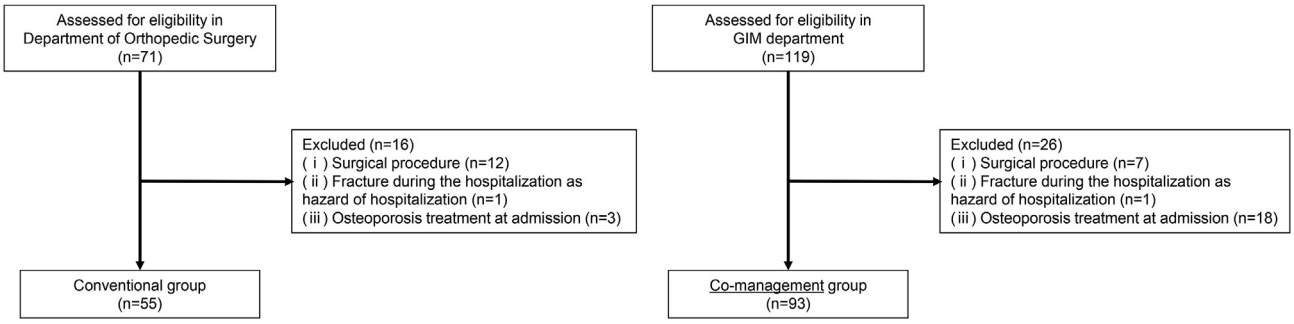

Fig. 1. Flowchart of patient inclusion.

Table 4
The rate of initiation of osteoporosis treatment.

	Conventional group (n = 55)	Co-management group (n = 93)
Initiation of osteoporosis treatment, n (%)	2 (3.6)	42 (45.2)
Alendronate, n (%)	1 (1.8)	37 (39.8)
Denosumab, n (%)	1 (1.8)	2 (2.2)
Minodronate, n (%)	0 (0.0)	3 (3.2)

Table 5
Reasons for non-initiation of osteoporosis treatment

Reason	n
Desire to be treated after consultation with their PCP after discharge	14
No consideration	9
Dental procedure is scheduled	7
Death during hospitalization, limited prognosis, CKD Stage 5	5
Difficulty keeping a seated position	5
No fixed place to live	4
Poor adherence is expected	3
Patient's refusal	2
Missing prescription	1

PCP: primary care physician, CKD: chronic kidney disease

4. Discussion

To the best of our knowledge, this is the first study to evaluate the effects of hospitalist co-management on the rate of initiation of osteoporosis treatment compared with orthopedic surgeon-led care. Patients with VCFs are conventionally treated by orthopedic surgeons in Japan, so this is the first study to evaluate medical care for hospitalized patients with VCFs from the perspective of internal medicine physicians in Japan. The rate of initiation of osteoporosis treatment was significantly higher in the co-management group. Also, more patients were considered for initiation of treatment, including those who did not ultimately undergo it. The information was transferred to the physician who took care of the patients after discharge in the co-management group. Other quality indicators were not significantly different from those in the conventional group. Our results provide important evidence in support of the use of hospitalist co-management to improve quality of care for elderly patients with VCFs.

4.1. Rate of initiation of osteoporosis treatment

The rate of initiation of osteoporosis treatment was higher in the co-management group and it was higher than the average in Japan [17]. The impact on the rate of initiation of osteoporosis treatment was shown to be consistent with previous study [18]. Each of the patients who did not get initiation of osteoporosis treatment had reasons for non-initiation. It suggests that the treatment decision was more individualized by co-management initiation in our study, similar to a previous report [19]. Effective education of health professionals has been reported to be necessary to achieve a higher rate of initiation of osteoporosis treatment [20]. Moreover, another study suggested that comprehensive geriatric assessment was the essential cornerstone of orthogeriatric care to improve clinical indicators including initiation of osteoporosis treatment [21]. Given these considerations, it is possible that the hospitalist's familiarity with elderly care including performing comprehensive geriatric assessment and adequate education in osteoporosis treatment contributed to the outcome in the co-management group in our study.

Osteoporosis treatment for secondary prevention does not necessarily need to be initiated during hospitalization. It would be unfair to suggest that orthopedic surgeon-led care is inferior to hospitalist care based on the protocol for describing the initiation of osteoporosis medication. The primary care physician (PCP) system, however, is not firmly defined in Japan and that there is uncertainty in who is responsible for subsequent osteoporosis management after discharge, so the inpatient setting presents an opportune time to initiate long-term medical therapy [22]. Our protocol-based management may be useful as one of the strategies to improve the rate of initiation of osteoporosis treatment. In all the patients with non-initiation, the reasons for non-initiation of the medication were clearly stated by the physician in the medical records. In addition, the information on the reasons for non-initiation and the need for future initiation was transferred to the physician who would take care of the patient after discharge. Hospitalists were responsible not only for initiating osteoporosis treatment during hospitalization, but also for recommending appropriate initiation after discharge, suggesting that improved transition of care and higher quality of care for osteoporosis may have been achieved in the co-management group.

4.2. Other clinical indicators

The effects of hospitalist co-management on LOS in orthopedic disease have been inconsistent because LOS sometimes depends on a wait for community support and institutional placement in the hospital during the study period [23,24]. However, comprehensive approach to medical and functional problems and early recognition and treatment of complications by geriatric care reportedly have potential benefit for LOS [25]. In our study, there was no significant difference in LOS between the two groups. Although patients with VCFs require a comprehensive approach, they mainly need appropriate cast prescription, pain control and rehabilitation. In addition, most of the patients in our study had mild disease with low risk of complications. These reasons may explain the lack of favorable result for co-management group in the study.

Hospitalist co-management for patients with orthopedic disease reportedly caused lower rate of complications during hospitalization and 30-day readmission [20,26]. The potential mechanism is better management of chronic medical conditions and better transition of care [9,26]. In our study, hospitalist co-management had lower tendency of rates of preventable complications and 30-day readmission, but without significant difference, this may be due to the small number of events and the patient population with mild disease who are less likely to benefit from comprehensive hospitalist care [9].

The number of elderly patients is increasing, and their management is often complicated due to comorbidities [9], so it may be increasingly burdensome for orthopedic surgeons only to manage by them. Hospitalist co-management with comprehensive hospital care allows orthopedic surgeons to focus on their specialties including surgery. Further study to investigate the effects on clinical indicators is needed, which may support the validation of hospitalist co-management.

4.3. Limitation

We acknowledge that there are several limitations in relation to this study. First, this is a single-center study with a small number of participants, and it was conducted in a private acute care hospital in urban area, so the result does not necessarily reflect the situation in Japan as a whole. However, in Japan, the definition and recognition of hospitalists have not yet been clearly defined, so it was necessary to start by conducting a single-center study. The advantage of

hospitalist co-management for patients with VCFs shown in this study needs to be proven in further studies. Second, this was a pre-post observational study, so it was not possible to consider any trends in VCFs over time. However, it is unlikely that the patient characteristics significantly changed during this study period and there was no difference in osteoporosis treatment which could be initiated, as no initiation of romosozumab was confirmed. Third, complications during hospitalization, especially delirium, were defined by what was available in the retrospective chart review because there were no records on confusion assessment method score. The number of incidences of delirium may therefore have been underestimated. Finally, we did not obtain follow-up data on long-term mortality and refracture. Further prospective studies are needed to resolve these issues.

5. Conclusion

Hospitalist co-management for patients with VCFs improved the rate of initiation of osteoporosis treatment compared with conventional orthopedic surgeon-led care. Hospitalist co-management had a potential benefit of improving clinical indicators for patients with VCFs.

Declaration of competing interest

None.

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Appendix A. Supplementary data

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