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ORIGINAL ARTICLE

Secondary prevention of minor trauma fractures: the effects of a tailored intervention—an observational study

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Abstract

Introduction Minor trauma fractures (MTF) in the elderly are associated with an increase in mortality, morbidity, and the risk of subsequent fractures. Often, these patients who sustain MTF have an underlying bone disease, such as osteopenia or osteoporosis. Osteoporosis is known to be underdiagnosed and undertreated, and adequate treatment is essential to reduce the occurrence of MTFs. At our hospital, this has led to the implementation of Osteofit, a patient-education-based intervention targeted at improving screening and prevention of osteoporosis, with the goal to reduce the rate of subsequent MTF.

Objective The aim of this study was to assess the efficacy of Osteofit in improving osteoporosis screening and treatment in patients after an initial MTF episode.

Methods The study is a prospective, single-center, cohort study of MTF patients aged 50 years or older. A standardized questionnaire and telephone interview were used to collect 1-year follow-up data. The primary outcome was the rate of patients undergoing Dual X-ray Absorptiometry (DXA) scanning. Secondary outcomes were the rate of patients with a diagnosis of osteoporosis or osteopenia, the rate of patients treated with anti-osteoporotic medication, and the rate of patients with a subsequent fracture. DXA scanning rate, the prevalence of a diagnosis (osteoporosis/osteopenia), and data on medical treatment for osteoporosis were compared to the results of a previous study in the same hospital, published in 2004.

Results Between 2012 and 2015, 411 of 823 eligible patients consented to participate and were included in this study. The mean age was 72 ± 9.3 years. Sixty-three percent (63.3%, $n = 252$) of the patients received a DXA scan, compared to 12.6% reported in our previous study. Of all patients who received a DXA scan, 199 (82.9%) were diagnosed with osteoporosis or osteopenia. A total of 95 patients (23.1%) received specific medical treatment for osteoporosis and 59.8% reported the intake of any unspecific medication (vitamin D, calcium, or both). Fifteen patients (3.9%) had a subsequent fracture as a result of a minor trauma fall.

Conclusion The implementation of a MTF secondary prevention program with dedicated health professionals improved the rate of patients who underwent DXA screening by fivefold. Despite this improvement, DXA screening was missed in over a third of patients, with only 23% of eligible patients receiving specific medical treatment for osteoporosis at 1-year follow-up. Consequently, this tailored intervention is a promising first step in improving geriatric fracture care. However, further work to improve the rate of osteoporosis screening and medical treatment initiation for the long-term prevention of subsequent MTF is recommended. We believe osteoporosis screening and adequate osteoporosis medication should be integrated as standard procedure in the aftercare of MTF.

Level of evidence: II.

Keywords Fracture · Secondary prevention · Osteopenia · Osteoporosis

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Introduction

Osteoporotic fragility fractures, also known as minor trauma fractures (MTF), are a growing public health problem in the aging population, associated with an enormous increase in disability, morbidity, mortality, and healthcare cost [1–8]. MTFs are often the first symptom of osteoporosis, a systemic disease characterized by loss of bone mineral density (BMD) and change in bone composition leading to increased bone fragility and fracture risk [1–3, 5–7]. The incidence of MTFs in the general population is estimated at 969 and 768 per 100,000 in women and men, respectively, equating to a lifetime risk in women of 40%. The annual costs in the year 2000 of osteoporotic fractures in Switzerland were estimated at 357 million CHF [2, 5].

Despite these numbers, numerous studies show that osteoporosis still remains underdiagnosed and undertreated [1–4, 9]. An osteoporotic fracture and lack of osteoporosis-specific medical treatment increases the risk of a subsequent fracture, especially in the early period following the initial fracture [2, 4, 6, 10]. Therefore, adequate osteoporosis screening and treatment is essential to minimize the risk of subsequent fracture, and thus there is a growing interest in identifying strategies for secondary prevention of osteoporosis, such as the Fracture Liaison Services (FLS).

In the largest hospital in Central Switzerland, the intent to improve osteoporosis screening and treatment has led to the implementation of Osteofit, a patient-tailored intervention combining surgical, rheumatologic, physiotherapeutic, endocrine, and radiologic care. The standardized intervention was based on an earlier initiative implemented in the same hospital in 2001–2002 called Osteocare [1]. This was a simple information program provided to surgeons or to the general practitioners responsible after discharge, targeting the prevention of subsequent fractures and the improvement of osteoporosis screening and treatment. The results of Osteocare were published in 2004. The purpose of Osteofit was to improve upon the previously described goals of Osteocare by assigning dedicated health professionals who identify, register, and help navigate MTF patients.

The aim of this study was to assess the efficacy of Osteofit in improving osteoporosis screening, to initiate medical treatment, and to prevent subsequent MTFs after an initial fracture episode.

Methods

This article was written in accordance with the STROBE statement [11].

Study design

This is a prospective cohort study of elderly trauma patients, conducted at a single level I trauma center in Switzerland. This study was approved by the ethics committee (Approval-Nr.: 13055). Data was prospectively derived from Osteofit, initiated in 2012. The data from the current study was compared to a similar cohort study undertaken at the same hospital and published in 2004 [1].

Osteofit program

Dedicated health professionals (i.e. physiotherapist or specialized nurse) were implemented and assigned to pre-screen all trauma patients for the inclusion into Osteofit. Patients were eligible to participate in Osteofit if they were 50 years of age or older and admitted for MTF, defined as a fall from standing height or less. Further inclusion criteria were defined for participation in the study and presented in Table 1.

To reduce the risk of a secondary fracture, Osteofit was designed to (a) improve post-fracture diagnosis and management of osteoporosis and (b) reduce the risk of subsequent falling. In order to reach these goals, the dedicated health professionals were assigned to (1) inform all Osteofit patients about their risk of osteoporosis and recurrent falling, (2) recommend basic anti-osteoporotic treatment with vitamin D and calcium, (3) encourage patients to undertake a Dual Energy X-ray Absorptiometry (DXA) scan for measuring BMD (unless performed within the last year prior to the fracture) and undergo specific treatment if recommended, and (4) visit the "Osteofit consult," a consult in which a specially trained physiotherapist would assess the patients' risk of falling and would provide information on fall prevention strategies.

Inpatients, when reachable, were personally visited by the health professionals during their hospital stay. Clinically not reachable patients and outpatients received the corresponding information and recommendations by both an informative letter and by telephone.

Patients were free to either undertake DXA scanning at our hospital or elsewhere. DXA results, along with medical therapy recommendations for the subgroup of patients who undertook the DXA scanning at our hospital, were transmitted to the patients' general practitioner (GP). The GP then could initiate treatment based on the recommendations of the rheumatologist or the endocrinologist. Furthermore, recommendations of appropriate fall prevention interventions for the subgroup of patients who decided to visit the "Osteofit consult" were also sent to the GP. Figure 1 shows the flowchart of "Osteofit" and the study conduct.

Study population

Patient recruitment started 1 year after the implementation of Osteofit. Patients who were referred to the emergency unit from May 2012 until December 2015, and subsequently enrolled into Osteofit according to the above Osteofit enrolment criteria, were eligible for this study. One year after the initial

Table 1 Eligibility criteria

Inclusion criteria	Exclusion criteria
• Older than 50 years • Low-energy fracture • Patient receiving ambulatory or stationary treatment	• Severe dementia or Alzheimer • Severe neurological diseases (e.g., multiple sclerosis, cerebrovascular accident, M. Parkinson, paraplegia) • Severe alcohol abuse • Non-judicious patients living in a health care institute (elderly-, nursing home) • Inability to speak German • Inability to attend the hospital • Age older than 50 years and ≤ 85 years

encounter, all eligible patients were sent an informative letter about the study. Informed consent was obtained from patients willing to participate in the study and a written multiple-choice questionnaire was administered.

Data collection

Baseline data including age, gender, inpatient or outpatient care, body mass index (BMI), and American Society of

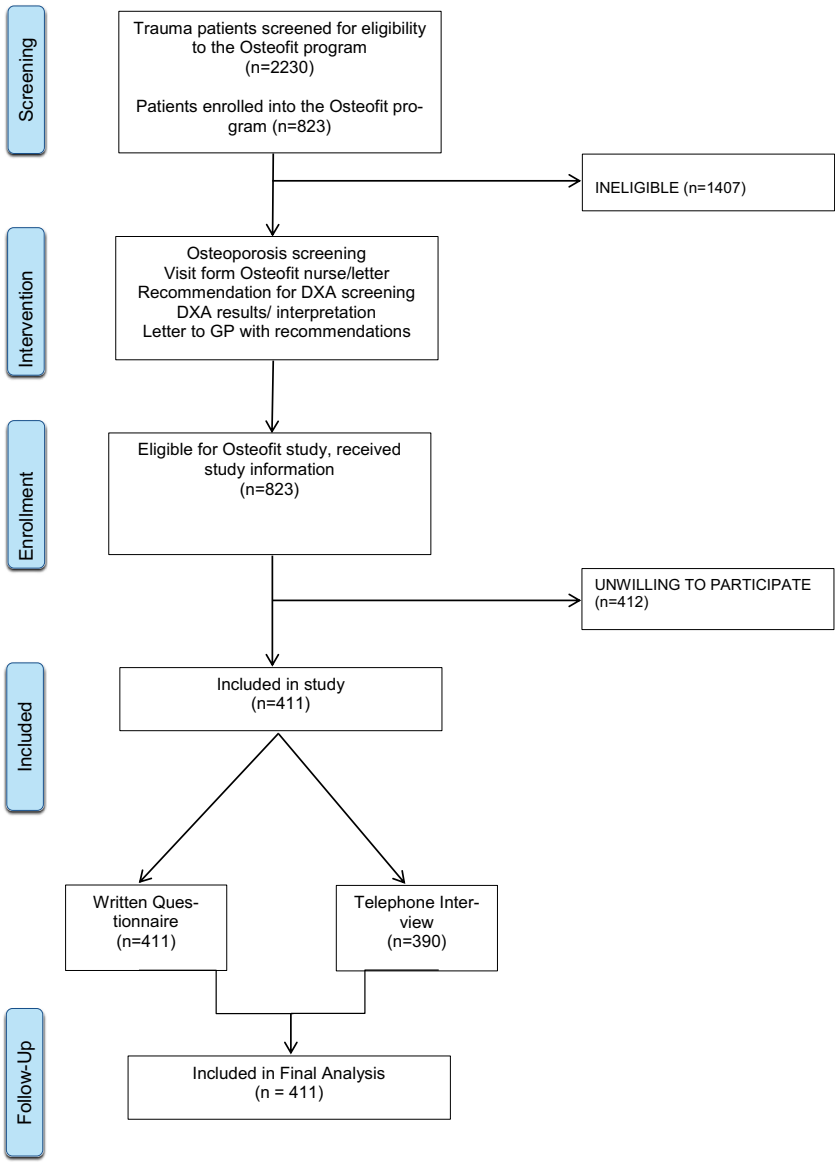

Fig. 1 Patient flowchart

Anesthesiologists (ASA) score were obtained from the Electronic Medical Record (EMR) [12]. The fractures were classified using the Arbeitsgemeinschaft für Osteosynthesefragen (AO) fracture classification system [13, 14]. The primary outcome of this study was the rate of patients that reported to have undertaken DXA screening [15].

Secondary outcomes were the rate of patients that reported to have a diagnosis of osteoporosis or osteopenia (defined according to the WHO standards), the rate of patients that reported undergoing treatment with anti-osteoporotic medication, and the rate of patients with a subsequent fracture [15]. Medical treatment was categorized into specific treatment: bisphosphonates, denosumab, teriparatide, hormone replacement therapy, and non-specific treatment (vitamin D and calcium). Patients were also asked about their nutritional habits to estimate whether they reached a daily calcium intake of at least 1000 mg. Medication history was reconciled in three ways to improve the validity of the data. First, patients were asked to report their medication use on the written questionnaire. Secondly, a medication history was again obtained during the telephone interview. This telephone interview was conducted by four independent study nurses in order to collect follow-up data and to improve the reliability of the questionnaire data. Finally, if available, the EMR was used to verify medication history. To compare non-participants to study participants, the following baseline data was also collected for non-participants: age, gender, fracture location, and treatment setting. As of 2013, all data was prospectively collected in an official study protocol by a study coordinator.

Statistical analysis

Baseline demographics were evaluated descriptively using total numbers (n) and percentages. The mean (M) along with the standard deviation (SD) were calculated for age. Missing values were assessed through available case analyses and excluded from analyses. For patients who had undertaken their DXA screening at our hospital, a subgroup analysis of the data was calculated to identify the proportion of patients with a diagnosis of osteoporosis as confirmed by DXA. Analysis was completed using SPSS Statistics version 24.0.0.1 (IBM Corporation Armonk, NY). Concordant data were compared to Osteocare data from 2004.

Results

Participant flow

Between 2012 and 2015, 2230 patients aged 50 years or older received treatment for a fracture of any kind, 823 of which met the eligibility criteria for the study. From the 823 eligible patients, 411 returned their informed consent and were therefore willing to participate. A total of 390 of 411 patients were reached by telephone for the secondary phone interview. All 411 patients otherwise returned the written questionnaire. A flowchart showing the number of patients at each stage of the study is shown in Fig. 1.

Patients' demographics

Baseline demographics are presented in Table 2. The mean age of study participants was 72 ± 9.3 years. One-fifth of the patients were male (20.2%). A total of 84 (25.3%) patients had an ASA score above 2 and 175 (45.4%) had a BMI over 25 kg/m2. Regarding the treatment setting, we found that 57.2% of the patients received in-hospital treatment. Fifty-six percent of patients sustained a fracture of the upper extremity (232 patients) and 34 % sustained a lower extremity fracture (140 patients); altogether, 90.6% of all fractures were extremity fractures. Analysis of non-study participants revealed that the mean age of non-participants was 72 ± 10.5 years. Participants and non-participants were comparable in means of gender, fracture distribution, and treatment setting ($P > 0.05$).

Primary outcome: rate of DXA screening

At the time of 1-year follow-up, 63.3% ($n = 252$) of the total study population had received a DXA scan; in 2004, this number was 12.6%. Of 252 patients who received a DXA scan, 199 patients (82.9%) received a diagnosis of either osteoporosis or osteopenia (as reported by the patients). Of these patients, DXA scans were available for 162 participants, a total of 98 (49.2%) were diagnosed with osteoporosis (T-score < − 2.5 SD) and 64 (32.1%) with osteopenia (T-score − 1 to − 2.5 SD). The remaining 37 patients all reported receiving a diagnosis of either osteopenia or osteoporosis, however the DXA scan for these patients was completed at institutions other than the study hospital, and therefore, we could not confirm an exact diagnosis.

Secondary outcomes: medication intake, recurrent falls, fractures

The intake of any medication for osteoporosis (bisphosphonates, hormonal treatment, teriparatide, denosumab, vitamin D, or calcium) was reported by 253 patients (61.7%). Calcium and vitamin D were the most frequently taken medications, with a total of 59.8% of patients reporting the usage of either calcium or vitamin D or both (calcium 39.3% and vitamin D 40.8%). A total of 202 patients (57.2%) were estimated to have reached the daily intake of 1000 mg calcium (nutrition and/or medication). The specific osteoporosis medications (such as hormone replacement therapy or antiresorptive treatment) were taken by 23.1% of all patients (95/411), this compares to 14.6% who received specific osteoporosis medication in 2004. In the 98 patients who received a confirmed osteoporosis diagnosis, 91 (92.9%) were taking some form of osteoporosis medication. More

Table 2 Baseline demographics

	Participants ($n = 411$)	Non-participants ($n = 412$)
Age (years) mean ± SD	71.9 ± 9.3	71.5 ± 10.5
Gender		
Male *n* (%)	83 (20.2)	89 (21.6)
Female *n* (%)	328 (79.8)	322 (78.2)
ASA classification		
ASA classification 1 *n* (%)	47 (14.0)	–
ASA classification 2 *n* (%)	204 (60.7)	–
ASA classification 3 *n* (%)	84 (25.0)	–
ASA classification 4 *n* (%)	1 (0.3)	–
Treatment setting		
Outpatient care *n* (%)	176 (42.8)	161 (39.1)
Inpatient care *n* (%)	235 (57.2)	250 (60.7)
Body mass index		
< 18 kg/m^2 (underweight) *n* (%)	11 (2.9)	–
18–24.9 kg/m^2 (normal weight) *n* (%)	199 (51.7)	–
25–29.9 kg/m^2 (overweight) *n* (%)	123 (31.9)	–
> 30 kg/m^2 (obese)	52 (13.5)	–
Fracture location		
Humerus *n* (%)	80 (19.5)	61 (14.9)
Clavicle *n* (%)	7 (1.7)	10 (2.4)
Rib fracture *n* (%)	7 (1.7)	9 (2.2)
Radius/ulna *n* (%)	139 (33.8)	141 (34.3)
Femur *n* (%)	62 (15.1)	58 (14.1)
Tibia/fibula/patella *n* (%)	22 (5.4)	23 (5.6)
Tibia/fibula, malleolar segment *n* (%)	46 (11.2)	43 (10.5)
Spine, cervical segment *n* (%)	1 (0.2)	1 (0.2)
Spine, thoracic segment *n* (%)	5 (1.2)	9 (2.2)
Spine, lumbar segment *n* (%)	13 (3.2)	10 (2.4)
Pelvic ring *n* (%)	12 (2.9)	18 (4.4)
Acetabulum *n* (%)	2 (0.5)	0 (0.0)
Hand *n* (%)	6 (1.5)	4 (1.0)
Foot *n* (%)	8 (1.9)	19 (4.6)
Craniomaxillofacial bones *n* (%)	1 (0.2)	0 (0.0)

n, number of patients. Numbers are noted in percentages of the total number of study patients (missing values were excluded from analysis). *SD*, standard deviation. *ASA classification*, American Society of Anesthesiologists Physical Status Classification System. ASA classification 1: a normal healthy patient. ASA classification 2: a patient with mild systemic disease. ASA classification 3: a patient with severe systemic disease. ASA classification 4: a patient with severe systemic disease that is a constant threat to life

specifically, 56 of the 98 patients (57.1%) were taking specific osteoporosis medications and 89 (90.8%) were taking non-specific osteoporosis medications. Of the 64 patients who received an osteopenia diagnosis, 48 (75.0%) were taking some form of osteoporosis medication, including 13 of 64 (20.3%) taking specific osteoporosis medication and 46 of 64 (71.9%) taking non-specific osteoporosis medication.

At 1-year follow-up, 15.5% of the patients (60 of 386) reported having at least one subsequent minor trauma fall. Of those who sustained a subsequent fall, 27 (45%) sought care from their general practitioner after the fall. Fifteen patients (3.9%) experienced a subsequent fracture due to the fall. Of these 15 patients with a subsequent fracture, four had not received a DXA scan (26.7%) at the time of the second fracture, and two (13.3%) had no osteoporosis, confirmed by DXA scan. Table 3 provides an overview of the outcomes.

Comparison cohort

Table 4 presents a comparison of the main results of the present study (Osteofit) and the Osteocare study in 2004.

Discussion

Osteoporotic fractures in the elderly population are a public health concern with an enormous burden of disability, morbidity, mortality, and increasing healthcare costs. In order to minimize the impact of these injuries, efforts are being made to screen patients who are at risk and attempt to prevent future osteoporosis-related fractures. This study evaluated a cohort of 411 consecutive patients treated for an MTF, who were enrolled in an integrative osteoporosis screening and prevention program at the largest hospital in central Switzerland. The rate of patients reporting to have performed DXA screening was 63.3% ($n = 252$).

Several studies report on DXA screening after an initial MTF. In a similar, Dutch, multicenter study of patients who sustained MTF (other than hand or foot), the rate of patients receiving DXA screening varied from 16 to 71% [16]. The national Swiss guidelines recommend providing DXA screening to patients with a vertebral MTF or a peripheral MTF [15].

Table 3 Postoperative outcome measures

DXA test	
Yes *n* (%)	252 (63.6)
No *n* (%)	144 (36.4)
*Osteoporosis *n* (%)	98 (49.2)
*Osteopenia *n* (%)	64 (32.1)
Subsequent fractures as a result of falling	
Yes *n* (%)	15 (3.9)
No *n* (%)	371 (96.1)
Subsequent falls	
0 falls *n* (%)	326 (84.5)
1 fall *n* (%)	44 (11.4)
≥ 2 falls *n* (%)	16 (4.1)
GP visits due to fall	
Yes	27 (45)
No	33 (55)
No. of patients taking any type of osteoporosis medication	253 (61.7)
Type of osteoporosis medication	
Bisphosphonates *n* (%)	78 (16.4)
Calcium *n* (%)	184 (38.7)
Vitamin D *n* (%)	190 (40)
Hormonal treatment *n* (%)	10 (2.1)
Denosumab *n* (%)	6 (1.3)
Thyroxin	7 (1.5)
No. of patients taking calcium or vitamin D	245 (59.8)

n, number of patients. Numbers are noted in percentages of the total number of study patients. *GP*, general practitioner. *DXA*, dual-energy X-ray absorptiometry scan. WHO criteria for the diagnosis of osteoporosis were used: Osteoporosis: T-score < − 2.5SD (standard deviation). Osteopenia: T-score − 1 to − 2.5 SD. No osteoporosis: T-score 0 to − 1 SD. Missing values were excluded from analysis. *Of n=162 patients with a DXA confirmed diagnosis

However, a Swiss study from 2008 showed that only 44% of MTF patients received a DXA scan postoperatively [3]. The rate of DXA screening in our hospital falls within this range and shows a significant increase compared to the data published in 2004. Even though the patients' and general practitioners' awareness of osteoporosis therefore seems to have improved with Osteofit, the rate of DXA screening still remains suboptimal. One reason for this deficit may be, that once the fracture has been treated, the importance of taking further measures to improve osteoporosis treatment and prevention of secondary fractures is likely to decline for many patients.

Numerous studies report the need for improvement in secondary fracture prevention by adequate medical management of osteoporosis [7–9]. Current pharmaceutical osteoporosis therapy has proven to be effective in reducing subsequent fractures [7, 9, 17]. However, many patients with osteoporosis do not receive adequate drug therapy. In the current study, the number of patients that received a DXA scan postoperatively after the first MTF was 63.3%, with 82.9% of these patients receiving a diagnosis of either osteoporosis or osteopenia. Despite the significant number of osteoporosis or osteopenia diagnosis, only 23.1% of the study population received specific medication for osteoporosis; respectively, only 57.1% of the 98 patients with a DXA confirmed diagnosis of osteoporosis ($T \leq -2.5$).

In the same center, a previous study on the effects of a simple information program (Osteocare) was conducted in 2004, demonstrating that only 12.6% of the MTF patients received a DXA scan and only 14.6% reported to intake specific osteoporosis medication. [1] Although, the current Osteofit intervention program has been effective in improving the DXA screening rate by fivefold, our findings demonstrate that there still remains not only a screening but also a large treatment gap, with only an 8.5% increase in the proportion of patients who received specific osteoporosis medication (whole study population) and with 42.9% of patients with an osteoporosis not being treated specifically. The screening gap may be attributed to concerns that an osteoporosis investigation is likely to lead to an additional drug consumption which may withhold patients and GP's from screening. Moreover, could the nature of a multidisciplinary team approach in MTF may lead to a loss of adherence to recommendations being made [18–20]. To overcome this, in accordance with others, we suggest considering the standardization of treatment in all patients over 50 years old with a combination of MTF and a low BMD.

Our study has several limitations. First, the participation rate of this study was 50%. This was considered low but acceptable since previous studies report similar participation rates [6, 21, 22]. Furthermore, it is well known that there is a decline in participation rates in epidemiologic studies in recent years and participation rates between 40 and 50% seem to be common [23]. Nevertheless, to evaluate the potential source of bias resulting from the low participation rate of this study, a

Table 4 Osteofit vs. Osteocare

	Osteofit ($n = 411$)	Osteocare ($n = 231$)
Participation rate *n* (%)	411/823 (50)	231/299 (77.2)
Gender		
Male *n* (%)	83 (20.2)	61 (26.4)
Female *n* (%)	328 (79.8)	170 (73.6)
Age (years)		
Male mean ± SD	71 ± 10	65 ± 7
Female mean ± SD	72 ± 9	68 ± 8
Fracture site		
Distal radius *n* (%)	139 (33.8)	79 (34)
Humerus *n* (%)	80 (19.5)	37 (16)
Proximal femur *n* (%)	62 (15.1)	44 (19)
Osteoporosis screening		
DXA scan	252 (63.3)	29 (12.6)
*Osteoporosis or osteopenia	199 (82.9)	29 (100)
Osteoporosis treatment		
Specific osteoporosis treatment *n* (%)	95 (23.1)	33 (14.6)

n, number of patients. Numbers are noted in percentages of the total number of study patients (missing values were excluded from analysis). *SD*, standard deviation. *DXA*, dual-energy X-ray absorptiometry. WHO criteria for the diagnosis of osteoporosis were used: Osteoporosis: T-score < −2.5SD (standard deviation). Osteopenia: T-score − 1 to − 2.5 SD. No osteoporosis: T-score 0 to − 1 SD

*Proportion of DXA scanned patients with either a diagnosis osteoporosis or osteopenia

comparison of baseline characteristics between participants to non-participants was performed. Based on the finding that participants and non-participants were comparable, we conclude the risk of bias to be minor. When assuming that responders are more likely to adhere to recommendations than non-responders, it is possible that our results considering DXA rate and "medical treatment" even being overestimated instead of being underestimated. Therefore, the lack of patients with MTF not being screened and treated for osteoporosis may be even larger than reported. Second, the direct comparison between Osteofit and Osteocare as presented in Table 4 needs to be treated with caution since recruitment process and length of follow-up in the two studies differed. The recruitment process for the Osteofit study was more intense as compared to Osteocare, in which only telephone contact by the study nurse was needed for basic data collection. Written informed consents and study invitations were only obtained from patients who had a DXA scan. Length of follow-up in Osteofit was 1 year, whereas in Osteocare, patients were contacted after a minimum of 6 months after MTF. This could have led to an underestimation of the DXA rate in Osteocare as compared to Osteofit.

Third, it is well known that patients tend to forget about their minor falls, and therefore, there exists the possibility of recall bias in this study [24]. However, subsequent fractures have a significant impact on patients' lives, often requiring readmission to the hospital setting. Therefore, we believe our results regarding the reporting of subsequent fracture to be reliable. A further shortcoming of this study was that some of the patients who reported to have undergone DXA screening were unaware of their exact diagnosis, unable to decipher whether they were diagnosed with osteoporosis or osteopenia. To prevent overestimating the number of patients with an osteoporosis diagnosis, we evaluated patients reporting a diagnosis of either "osteoporosis or osteopenia" and performed subgroup analysis of patients who had had DXA screening at our hospital. Furthermore, due to the use of four different interviewers, observer bias may have occurred. Since the interviewers were provided with oral instructions and training prior to study conduct, we believe the risk of bias to be minor. Finally, patient selection criteria need to be considered when interpreting the results of this study and comparing it with others. Our study cohort may be healthier and overall at less risk for fracture than those of similar studies, potentially explaining our comparatively low subsequent fracture rate.

Conclusion

This study shows that an osteoporosis screening and intervention program for the management of patients with MTF improved the rate of patients receiving DXA screening, potentially contributing to a decrease in subsequent fractures. The number of patients that received specific medical treatment, however, remains alarmingly low. Consequently, even though this tailored intervention is a promising first step in improving

geriatric fracture care, there is a strong need for further improvement. We believe that fracture liaison services should be not only established but also empowered to initiate and control appropriate actions.

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