Osteoporos Int (2006) 17: 965–970
DOI 10.1007/s00198-005-0064-z

ORIGINAL ARTICLE

Targeted education improves the very low recognition of vertebral fractures and osteoporosis management by general internists

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Received: 8 August 2005 / Accepted: 22 December 2005 / Published online: 22 April 2006

Abstract *Introduction:* Vertebral fractures in older persons are strong predictors of subsequent fracture risk but remain largely under-recognized. To evaluate the impact of an educational intervention on the recognition of vertebral fractures and the prescription of anti-osteoporosis treatment among general internists, we conducted a prospective study in a service of general internal medicine of a large university teaching hospital in Geneva, Switzerland. During a 3.5-month observation period (phase 1), all lateral spinal or chest radiographs performed on consecutive inpatients over 60 years were reviewed by two independent investigators, and vertebral fractures were graded according to their severity. *Methods:* Results were compared with radiology reports and general internists' discharge summaries. During the following 2-month intervention period (phase 2), internists were actively educated about vertebral fracture identification by means of lectures, posters and flyers. Radiologists did not receive this educational strategy and served as controls. *Results:* Among 292 consecutive patients (54% men; range: 60–97 years) included in phase 1, 85 (29%) were identified by investigators as having at least one vertebral fracture; radiologists detected 29 (34%), and internists detected 19 (22%). During the intervention phase, 58 (34%) of 172 patients were identified with vertebral fractures by investigators; radiologists detected 13 patients (22%) whereas among internists the detection rate almost doubled (25/58 patients, 43%; p=0.008 compared to phase 1). The percentage of patients with vertebral fracture who benefitted from an osteoporosis medical management increased from 11% (phase 1) to 40% (phase 2, p<0.03). *Conclusion:* Our findings confirm the large under-recognition of vertebral fractures, irrespective of their severity, and demonstrate that a simple educational strategy can significantly improve their detection on routine radiographs and, consequently, improve osteoporosis management.

Keywords Education · Fracture risk · Osteoporosis · Vertebral fracture

Pierre Casez managed the protocol, examined all of the X-rays, collected and analyzed the data, wrote the manuscript. Brigitte Uebelhart examined all the X-rays and contributed to the data analysis and to the writing of the paper. Martine Louis-Simonet, Jean-Michel Gaspoz and Serge Ferrari contributed to the protocol design, participated in the data analysis and to the writing of the paper. René Rizzoli designed the protocol, contributed to the data analysis and to the writing of the paper.

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Introduction

At the age of 50, the lifetime risk of osteoporotic fractures is greater than 45% for women and 20% for men [1]. In addition to being associated with long-term morbidity, decreased quality of life [2, 3] and increased mortality [4–7], osteoporotic fractures are a major risk factor for subsequent fractures [8–10], irrespective of bone mineral density (BMD) [11]. Following a vertebral fracture, 20% of patients experience a subsequent fracture within 1 year [12]. However, most intervention trials have demonstrated the efficacy of anti-osteoporosis drugs in patients with osteoporosis and at least one prevalent vertebral fracture [13–21].

Patients with a prevalent fragility fracture should therefore be considered to be at high risk for subsequent fractures and be thoroughly evaluated and eventually considered for treatment for osteoporosis. However, diagnostic and/or treatment procedures are rarely initiated after

low-energy fractures [22–27]. Two retrospective studies on patients suffering from a moderate-to-severe vertebral fracture revealed that the fracture was not recognized on routine radiographs in a large proportion of the patients (23–40%) and that even fewer patients had been reported to be suffering from osteoporosis, as noted in the medical chart (25%), or to have been treated for osteoporosis (20–24%) [28, 29].

These observations prompted us to prospectively investigate both the prevalence of radiological vertebral fractures in a general internal medicine service and their recognition rate by internists compared to radiologists. We then implemented an educational program targeted to an improved recognition of vertebral fractures and assessed its impact on internists with the aim of increasing the percentage of patients prescribed an anti-osteoporosis drug at discharge.

Methods

Patients

Patients of both sexes over 60 years of age who had been admitted to a 100-bed service of General Internal Medicine at the Geneva University Hospitals, Geneva, Switzerland were included in this study. Exclusion criteria were death during hospitalization, Scheuermann's disease, radiologic examination without a radiology report and a radiograph of insufficient quality for analysis.

Vertebral fracture detection

During an initial observation period of 3.5 months (phase 1), the main investigator (PC) reviewed all lateral chest and lumbar spine radiographs routinely performed in consecutive patients. In the case of multiple hospitalizations during the study period, radiographs obtained during each hospital stay were considered as one observation. Available radiology documents were both numeric and printed on films. Radiographs showing one (or more) vertebral deformity were reviewed by a second independent investigator (BU) to confirm the diagnosis of vertebral fracture.

Vertebral deformities were determined by a validated semiquantitative visual grading [30]. All vertebral deformities of grade 1 or more (loss of vertebral body height ≥20%) were considered as vertebral fractures. The reasons for choosing a semiquantitative method were its high predictive value for osteoporosis [31] and good correlation with vertebral fracture morphometric determination [32, 33] and because radiographic examinations were performed as part of routine care – i.e. for any indication rather than under strict conditions suitable for precise morphometric analyses. Vertebrae from T3 to L2 for chest radiographs and from T11 to L4 for lumbar spine examination were evaluated and classified in four categories: normal: grade 0 (SQ0); mild deformity: grade 1 (SQ1, 20–25% reduction in height); moderate deformity: grade 2 (SQ2, 25–40% reduction in height); and severe deformity: grade 3 (SQ3, >40% reduction in height). Intra-main-investigator coefficient of variation (kappa) was 0.85, and inter-investigators' coefficient ranged between 0.69 and 0.78 according to vertebral fracture level and grade.

Radiology reports were screened for reporting of a vertebral fracture, and diagnosis and discharge summaries by general internists were screened for reporting of the following: a vertebral fracture diagnosis; osteoporosis risk factors (age of menopause, fracture history, corticosteroid treatment, alcohol consumption and tobacco use, hyperparathyroidism, hyperthyroidism); prescription of anti-osteoporosis drugs (calcium, vitamin D, bisphosphonates, selective estrogen receptor modulators (SERMs) and hormone replacement therapy); principal diagnosis; co-morbidities abstracted as Charlson comorbidity scores [34]; length of stay. It should be noted that all residents had access to numeric images on their office computers with software allowing modification of brightness and contrast, and zooming.

Educational intervention

The subsequent 2-month educational intervention (phase 2) included short communications about osteoporosis during rounds, posters illustrating vertebral deformity classification displayed in residents' offices, cartoon-like posters with messages intended to serve as alerts for vertebral fractures hung on residents' office doors (and changed every 2 weeks) and flyers with vertebral deformity classification and a vertebral fracture management algorithm distributed to all residents. To assess the impact of the intervention on internists' ability to report vertebral fractures, we estimated the probability that for each patient with one or more vertebral fracture, the internist would specify the diagnosis in the medical report.

Statistical analysis

Patient characteristics and the percentage with prevalent vertebral fractures detected by radiologists and general internists, respectively, are presented as means ± standard deviation (SD). The Chi-square test was used to compare the percentage of patients with prevalent vertebral fractures identified through radiology reports and residents' discharge summaries with the percentage of patients with prevalent vertebral fractures identified by the investigators, the percentage of patients identified by internists before and after the educational program (phase 1 vs. phase 2) and patient characteristics between the two phases. Furthermore, we built a logistic regression model to estimate the odds of vertebral fracture detection between the two phases and related this to the independent effects of the intervention and multiple covariates (age, sex, number of vertebral fractures, history of fracture, history of corticoid use, history of neoplasia, vertebral fracture grade and Charlson comorbidity index score). Analyses were performed with EpiInfo6 v. 6.04dfr software [CDC, World Health Organi-

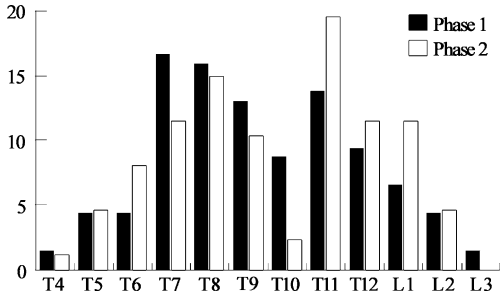

Fig. 1 Distribution of vertebral fracture (in percentages). There was no difference between phases 1 and 2

zation (WHO)] and STATA 7.0 software (Stata, College Station, Tex.); $p<0.05$ was chosen as the minimal level of significance.

Role of the funding source

The funding source had no role in study design, data collection, data analysis, data interpretation, writing of the report or the decision to submit this report for publication.

Results

During the 5.5-month study period, 2403 patients ≥60 years old were admitted to the General Internal Medicine wards at the Geneva University Hospitals, of whom 698 had lateral chest or lumbar radiographic examinations for multiple purposes. Of these 698 patients, we excluded those who died during hospitalization (n=27, 3.9%) and those with radiography of insufficient quality for analysis (n=35, 5%) and with missing radiology reports (radiograph performed in the emergency ward; n=172, 24.6%). Ultimately, 464 (66%) of the 698 eligible patients were included in the analysis: 292 during phase 1 (observation) and 172 during phase 2 (education).

Characteristics of patients with vertebral fractures

Patient characteristics, including mean age (75.9± 8.6 years), age distribution, gender, principal diagnoses, co-morbidities (Charlson score), history of fracture and corticoid treatment (past or present), were similar in both phases (data not shown). One hundred and forty-three (31%) patients had at least one vertebral deformity of grade 1 or more: 85 in phase 1 and 58 in phase 2.

Vertebral deformities were more frequent in the mid-thoracic and thoraco-lumbar junction regions and were similarly distributed in phases 1 and 2 (Fig. 1). Fractured and not fractured patients differed by age (78.6±8.7 vs. 74.6±8.40 years, respectively; $p<0.001$) and by history of fracture [odds ratio (OR) for patients with history of a fracture compared to those without: 5.6; $p<0.001$]. Differences for corticosteroid use (current or past) were close to significance (OR for patients using corticosteroids compared to those who were not: 1.7; $p=0.062$).

Detection rate among internists and radiologists

During phase 1, the number of patients with at least one vertebral fracture as determined by the investigators was 29% overall and 20% when only grade 2 or higher fractures were taken into consideration. The percentage of subjects with prevalent vertebral fractures reported by radiologists was slightly higher than that reported by the internists (34 vs. 22%, respectively; $p=0.088$). When only deformities of grade 2 and higher were considered, the corresponding values were 46 and 31%, respectively (Table 1). Several clinical risk factors influenced the probability of detecting patients with vertebral fractures. Hence, the odds for vertebral fracture recognition were higher for women and for fractures of grade 2 or more, in patients with a history of fracture and in patients with corticosteroid therapy, but multiple fractures did not influence their detection (Table 2). In addition, vertebral fracture at the thoracic vertebra T9 was more frequently recognized by internists than those at other locations ($p<0.009$; data not shown). In contrast, diagnosis of neoplasia did not significantly influence recognition rates (Table 2). It is noteworthy that only two patients were diagnosed as having vertebral fractures by radiologists but not by the investigators (false-positive): in one case, the apparent fracture was explained by the presence of severe scoliosis and in the other, by an image artifact due to the presence of bronchopneumonia.

Table 1 Number of patients with identified vertebral fractures classified by the study phases and the doctors' specialty

	Phase 1		Phase 2			
	Investigators n(%)	Radiologists n(%)	Internists n(%)	Investigators n(%)	Radiologists n(%)	Internists n(%)
All vertebral fractures	85(100)	29(34)	19(22)	58(100)	13(22)	25(43)*, **
SQ2–SQ3 only	59(100)	27(46)	18(31)	44(100)	11(25)***	24(55)*, **
SQ3 only	29(100)	16(55)	11(38)	18(100)	5(28)	9(50)

* $p<0.02$ as compared with the radiologist recognition rate in phase 2
**$p<0.01$ and ***$p<0.03$ as compared with phase 1 in the corresponding specialty group

Table 2 Adjusted odds ratio (OR) of correct diagnosis of vertebral fractures by internists and radiologists (*CI 95%* 95% confidence interval)

	Internists			Radiologists		
	OR	CI 95%	*p*	OR	CI 95%	*p*
Age range (years)						
60–69	1	–	–	1	–	–
70–79	0.8	0.2–3.7	0.797	1.1	0.3–3.9	0.872
80–89	1.2	0.3–5.3	0.799	1.0	0.3–3.5	0.996
>90	1.2	0.2–8.7	0.829	0.7	0.1–4.3	0.713
Sex (women vs. men)	3	1.1–8.2	0.031	3.1	1.4–7.1	0.008
Number of vertebral fractures (per additional fracture)	1.2	0.8–1.9	0.413	0.9	0.6–1.3	0.646
History of fracture[a]	4.8	1.8–12.7	0.001	–	–	–
Corticosteroid use[b]	5.1	1.4–17.9	0.012	–	–	–
Neoplasia[b]	0.6	0.2–2.3	0.614	–	–	–
Vertebral fracture grade (≥2 vs. 1)	16.8	3.29–86.2	0.001	5.9	1.8–19.2	0.003
Charlson comorbidity index score	1.2	0.9–1.5	0.136	–	–	–
Study phase (intervention vs. observation)	4.1	1.5–18.8	0.005	0.5	0.2–1.2	0.109

[a]Leg, hip, rib, arm and forearm fracture history
[b]Past or present

Impact of the educational intervention on vertebral fracture detection

During phase 2, the overall prevalence of vertebral fractures as determined by the investigators was 34% (26% for grade ≥2). Meanwhile, general internists exposed to a targeted educational program significantly improved their recognition rate of vertebral fractures, which increased from 22% in phase 1 to 43% ($p \leq 0.008$ compared with phase 1). Hence, the odds for vertebral fracture detection following the introduction of the educational program were as high as 4.5 compared to the detection rate pre-intervention (Table 2). In contrast, radiologists not exposed to the educational program (controls) maintained a low rate of detection during this period (22%; $p<0.02$ vs. internists). When only vertebral deformities of grade 2 and higher were taken into consideration, the corresponding detection rates were 55% (internists) and 25% (radiologists) ($p<0.02$ for comparison) (Table 1). This improvement in reporting patients with vertebral fractures among internists resulted primarily from a better detection that had not previously been identified by radiologists (7 vs. 28% before and after education, respectively; $p<0.001$). This observation shows that internists were examining and evaluating the radiologic images independently of the radiology reports and that their ability to newly diagnose vertebral fractures had been improved by the teaching program. In addition, the proportion of fractures determined from radiology reports that internists subsequently reported in the discharge summary (45 and 69% before and after education, respectively) also tended to improve (Fig. 2).

This educational strategy also modified the way in which internists reported vertebral fractures in their discharge summary. Whereas only 11% (2/19) of vertebral fractures recognized by internists correctly qualified as "fractures" during phase 1, 56% (14/25) were correctly identified in their discharge summaries during phase 2 ($p<0.002$). Meanwhile, no significant changes occurred among radiologists who adequately defined less than 8% of vertebral fractures identified as "fractures" in their reports.

Most importantly, the percentage of patients with vertebral fracture who benefitted from an osteoporosis medical management [prescription of examinations (chemistry, dual energy x-ray absorptiometry) to investigate bone disease or the adequate prescription of drugs against osteoporosis] significantly increased from 11% (phase 1) to 40% (phase 2, $p<0.03$).

Discussion

In this prospective study conducted at a large university teaching hospital, we confirmed that prevalent vertebral fractures on routine lateral radiographs of chest and lumbar spine remain largely under-recognized by both radiologists and general internists. Detection rates of patients with at least one moderate-to-severe fracture (46%) was a little less than that found by Majumdar and colleagues (60%) [29]

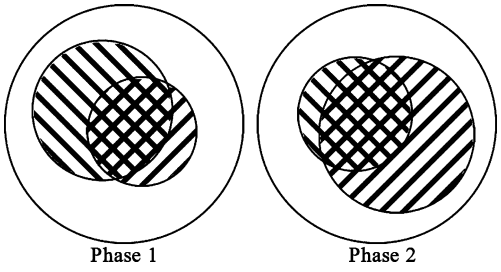

Fig. 2 Vertebral fracture recognition. *White bars* patients with vertebral fracture detected by investigators, *diagonally-striped bars* (*high-left to low-right*) percentage of patients detected by radiologists, but not by general internists, *diagonally-striped bars* (*high-right to low-left*) percentage of patients detected by general internists, but not radiologists, *diamond-marked bars* percentage of patients detected by both general internist residents and radiologists. In phase 2, the percentage of vertebral fractures reported by general internists but not by radiologists was significantly higher ($p<0.001$)

but approximately the same as that found by Gehlbach in his retrospective study (52%) [28]. An assessment of the impact of an educational intervention program targeted to vertebral fracture recognition among internists showed that the identification of fracture patients improved by approximately twofold. Furthermore, the percentage of patients with vertebral fracture who benefitted from an osteoporosis medical management increased from 11% (phase 1) to 40% (phase 2; $p<0.03$), indicating that the educational intervention had led to a greater awareness and knowledge of the disease. The high prevalence of patients older than 60 years of age with vertebral fractures in this prospective study is in keeping with results from a previous retrospective survey performed in a similar setting [28]. It is also compatible with large epidemiological studies on vertebral fracture incidence in the aging population [2, 35]. A low awareness of osteoporosis and its complications by both patients and doctors has been consistently found. Hence, not only vertebral fractures but also fractures of the proximal femur do not lead to consistent modifications in patient management [2, 22, 24–27]. This is also true for forearm fractures, for which only a minority of patients receive appropriate investigation and treatment [23].

The twofold or more increase in the risk of subsequent osteoporotic fractures associated with prevalent vertebral deformities [1, 9, 11, 12] strongly indicates that the identification of vertebral fractures represents an important step towards an osteoporosis case-finding strategy. The yield of such a strategy is similar or even superior to the screening of BMD by dual X-ray absorptiometry [36]. Taken together with the evidence that vertebral fracture also predicts the response to anti-osteoporosis therapy [37], it may be emphasized that upon admission to hospital, patients older than 60 years should be considered to be at high risk of osteoporosis and that their routine radiographs should be examined accordingly.

However, our study has several limitations. Patients were admitted to the hospital for an acute illness, for which routine radiographic examinations were performed. In this context, it is understandable that low-grade vertebral deformities – i.e. SQ1 – would be less easily detected. Even restricting our analysis to vertebral fractures of higher grades, such as SQ2 and SQ3 in which the decrease in vertebral body height is greater than 25%, still showed a detection rate of 50% or less. It remains possible, therefore, that both radiologists and general internists actually detected vertebral fractures but were not reporting them because their focus was primarily on the main diagnosis leading to hospitalization. In addition, we cannot exclude that the educational intervention led to a higher reporting rather than a higher recognition of vertebral fractures. Nevertheless, by using the radiologists as a control group not exposed to targeted education, we were able to demonstrate that the educational program encouraged internists to self-analyze the radiographic documents and not to only rely on radiology reports. Moreover, our intervention also triggered higher anti-osteoporosis treatment rates, thus suggesting that the recognition of vertebral fracture as a hallmark of osteoporosis was truly assimilated among internists. However it should not be underemphasized that about one-half of the vertebral fractures detected by the investigators still remained unidentified according to the internists' discharge summaries.

We were also unable to evaluate whether the improved recognition rate of vertebral fractures will be maintained after the end of the intervention. Considering that most general internists at a major teaching hospital are in training and rotate from one service to another, it would probably be necessary to periodically reinforce such intervention programs to maintain a high rate of vertebral fracture detection.

In conclusion, from a cost-effectiveness perspective [15], under-recognition of vertebral fractures on routine radiographic examinations represents the loss of a great opportunity to identify patients at high risk of fracture who may benefit from osteoporosis treatment. In that perspective, a major effort should be devoted to implement vertebral fracture recognition in postgraduate teaching programs for both radiologists and general internists [38].

Acknowledgements We are indebted to the members of the Department of Radiology for their collaboration. We thank Dr. M. Kossovsky for his valuable help in the statistical analysis, and Mrs. R. Sudan for her careful reading of the manuscript. This survey was made possible thanks to grants from the Geneva University Hospitals (support of the investigator). Rene Rizzoli had full access to all of the data in the study and takes the responsibility for the integrity of the data and the accuracy of the data analysis.

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