



Use of Calscan for improving osteoporosis care in the older patient admitted with hip fracture

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To determine whether bone mineral density measurement using the Calscan successfully predicts the actual bone mineral density, as measured by dual-energy X-ray absorptiometry. We included all patients ≥ 65 years with a hip fracture screened on osteoporosis by both dual-energy X-ray absorptiometry and the Calscan during the period April 2008 to April 2011. The bone mineral density was expressed as a T-score. For the Calscan T-score, thresholds were defined such that patients with and without osteoporosis could be identified with 90% certainty. Patients with a Calscan T-score above the upper threshold were considered to be non-osteoporotic and those with a Calscan T-score below the lower threshold considered osteoporotic. Patients whose Calscan T-score lay between the two thresholds could only be classified by means of DXA. The correlation between dual-energy X-ray absorptiometry and the Calscan was 0.61. The Calscan identified approximately 25% of patients as osteoporotic and 25% as non-osteoporotic. The upper threshold was found to be -1.8SD and the lower threshold -3.5SD. Osteoporosis screening by dual-energy X-ray absorptiometry had been carried out in 44% of patients. This percentage could theoretically rise to $> 70\%$ if the Calscan is implemented in osteoporosis screening, while costs of such screening appear to be lower, as long as a sufficient number of patients are screened.

Keywords : Calscan ; dual x-ray absorptiometry ; osteoporosis ; hip fracture.

INTRODUCTION

Hip fractures are a major problem in health care. Each year in the Netherlands approximately 17,000 patients are admitted with a hip fracture and this number is set to increase in the coming years (4,17). The costs of treating this patient group amount to about 391 million euros per year. Quality of life is clearly reduced in this patient group and optimizing their care is important, both to limit costs and improve quality of life (14,21).

An important part of such care optimization is screening for osteoporosis (3). Osteoporosis is a major risk factor for hip fracture and treatment of osteoporosis can prevent 40% of subsequent osteoporotic fractures (16). In our hospital, osteoporosis screening is a standard part of the care plan for older

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patients with a (hip) fracture, and is specified in the care pathways of the Geriatric Trauma Unit (GTU). At the GTU, the care for older fracture patients is continuously evaluated and optimized, which helps improve the quality of care (12). An interim evaluation revealed that only 40% of patients admitted to the GTU were actually screened for osteoporosis. This percentage was lower than expected – other studies have demonstrated levels of 70% – and must be increased in order to provide patients with maximum effective care (13,23). It may well be possible to achieve this using peripheral dual-energy X-ray absorptiometry (pDXA). Earlier studies have shown that pDXA and axial dual-energy X-ray absorptiometry (DXA) have equal predictive value for estimating the risk of fracture at any skeletal site (15,18). One of these peripheral measurement devices is the Calscan, which measures the BMD at the calcaneus. Compared to DXA, the Calscan is smaller, cheaper, portable, results in a lower radiation dose and can be applied on the hospital ward (20). This enables osteoporosis screening to be conducted during the patient's stay in hospital, which is a big advantage over DXA. If measurement of bone mineral density (BMD) using pDXA proves to be a valid technique, the percentage of patients that are screened for osteoporosis will most likely increase.

The aim of this study was to determine whether BMD measurement using pDXA successfully predicts the actual BMD, as measured using DXA, in patients with a hip fracture.

PATIENTS AND METHODS

This is a retrospective study conducted in a non-academic teaching hospital in the Netherlands.

All patients ≥ 65 years who were admitted to the GTU with a hip fracture from April 2008 to April 2011 and who had undergone osteoporosis screening at our fracture prevention clinic (FP clinic) were eligible for inclusion in this study. Exclusion criteria for osteoporosis screening at the FP clinic were dementia, a pathological fracture, referral to another specialty, recent screening for osteoporosis, or an address outside the hospital's drawing area. Patients were included retrospectively by searching in the electronic hospital information system for treatment code 820 (hip fracture) of the 'International Classification of Diseases' (ICD-9) (7). Patients are

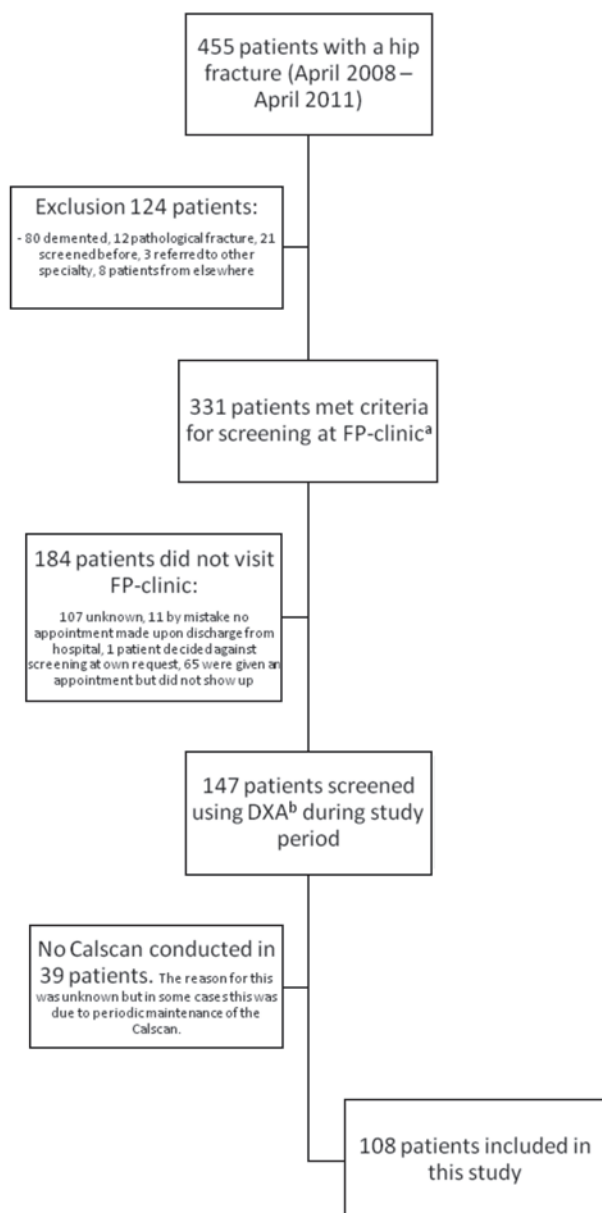
screened at our FP clinic with both DXA and pDXA. We identified a total of 455 patients with a hip fracture. Of these 455 patients, 124 were excluded. We found that 108 of the 331 patients that should have been screened for osteoporosis with both DXA and pDXA had undergone both scans (Fig. 1). Our study population therefore consisted of 108 patients.

DXA is the golden standard for measuring BMD (11,15). The densitometer used at our FP clinic is the Hologic Discovery A (Hologic, Bedford, MA, USA). The scan protocol takes about 20 minutes and the instrument is calibrated daily with a phantom. BMD is measured at the lumbar spine and the left hip and expressed as a T-score, which is a comparison between the BMD measured and peak bone density. According to the World Health Organization's definition, a T-score $\leq -2.5SD$ indicates the presence of osteoporosis; a T-score between $-1SD$ and $-2.5SD$ indicates the presence of osteopenia; and a T-score $> -1SD$ is considered to be normal (1).

The apparatus used for pDXA was the Calscan (DXL Calscan, Demetech AB, Solna, Sweden). The Calscan combines DXA and laser technology, thereby allowing the BMD to be measured at the calcaneus (19,20). The optimal scan position is determined automatically. The scan protocol for the Calscan takes about 5 minutes and the instrument is calibrated automatically before each measurement. The results are also expressed as a T-score and are available immediately following the scan.

To determine the suitability of Calscan as a replacement for DXA, we compared the values obtained with the Calscan with those obtained with DXA. A high correlation would mean that the Calscan is a valid measuring instrument. By calculating thresholds for the Calscan T-score, we were able to predict when DXA scanning might not be necessary. These thresholds for the Calscan T-score were defined such that osteoporotic patients could be identified with 90% sensitivity and specificity; in other words, 90% of patients *with* osteoporosis would have a Calscan T-score below the upper threshold and 90% of patients *without* osteoporosis would have a Calscan T-score above the lower threshold. Similarly, patients with a Calscan T-score below the lower threshold could be classified as having osteoporosis, and patients with a Calscan T-score above the upper threshold as not having osteoporosis. Patients with a Calscan T-score between the two thresholds could only be classified by means of DXA (5).

A complete cost effectiveness analysis with the data presented here was not possible since the study is retrospective and the Calscan and DXA scans were both performed at the FP clinic. However, it was possible to



^a FP-clinic : fracture prevention clinic.

^b DXA : dual-energy X-ray absorptiometry.

Fig. 1. — Flow chart showing patients ≥ 65 years who were admitted to our hospital with a hip fracture and who were screened for osteoporosis at the FP-clinic.

calculate the costs of osteoporosis screening using DXA. In our clinic, these costs amount to €75 per patient. We were also able to calculate the theoretical costs if the Calscan had been used in the screening for osteoporosis

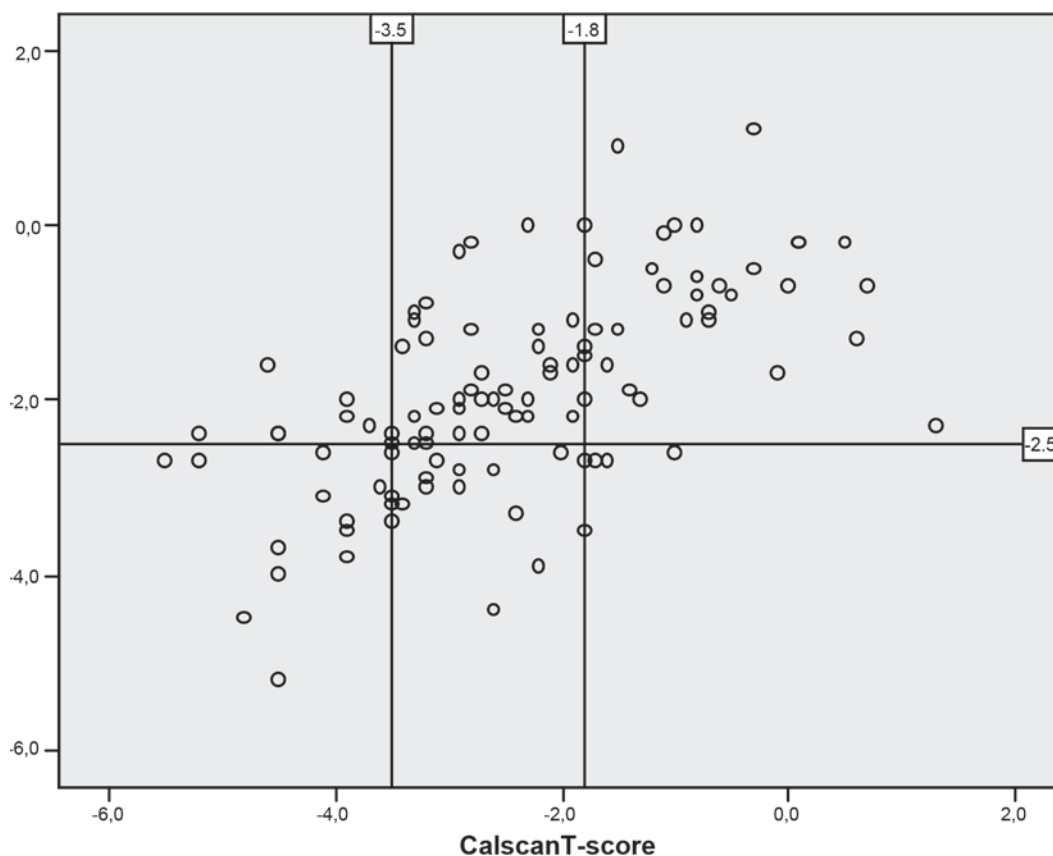
at the ward, during admission to the hospital. These costs can be split into a non-recurring expense of €20,000 for purchasing the Calscan and the yearly maintenance costs of €2,500. As there is no need for specialised personnel to operate the Calscan and it takes only 5 minutes per patient, the Calscan can be operated by the nursing staff at the ward. Therefore, this will not incur additional costs. Patients who could not be adequately classified using the Calscan T-score would require further scanning using DXA, which costs €75 per patient.

Statistical analysis was performed using SPSS software. The results are expressed as mean and standard deviation or range. The Pearson correlation coefficient was used to determine the relationship between BMD measured using DXA and BMD measured using the Calscan. The thresholds for the Calscan were calculated using contingency tables. The 95% confidence intervals were also calculated.

RESULTS

Of the 108 patients, 31 were male and 77 were female. The mean age was 77.5 years (SD 7.3). For BMD measurement using DXA, the mean T-score was -1.91 SD (range : -5.2 to 1.1 SD) and for the Calscan -2.40 SD (range : -5.5 to 1.3 SD). The correlation between DXA and the Calscan was $r = 0.61$ ($p < 0.001$), which means that 36% of the variance in DXA could be accounted for by the Calscan T-score.

In total, based on the DXA measurement, 35 patients could be classified as having osteoporosis and 73 as not having osteoporosis. Of these 35 osteoporotic patients, 91.4% (95%CI : 77-98%) had a Calscan T-score ≤ -1.8 SD. In order to correctly classify 90% of the patients with osteoporosis, the upper threshold for the Calscan T-score was set at -1.8 SD. Of the 73 non-osteoporotic patients, 89% (95%CI : 80-95%) had a Calscan T-score > -3.5 SD. In order to correctly classify about 90% of the patients without osteoporosis, the lower threshold for the Calscan T-score was set at -3.5 SD. Using these threshold values, 25 patients with a Calscan T-score ≤ -3.5 SD were considered to be osteoporotic and 32 patients with a Calscan T-score > -1.8 SD were considered to be non-osteoporotic. Therefore, 57 of the 108 patients (53%) could be classified on the basis of the Calscan T-score (Fig. 2, Table I).



- ^a DXA : dual-energy X-ray absorptiometry.
- ^b Lowest T-score : Lowest T-score measured with DXA.
- ^c WHO : World Health Organization.

Fig. 2. — Relationship between Calscan T-score and DXA^a T-score. In this figure the thresholds for the Calscan are determined according to the WHO^c definition for osteoporosis ($T \leq -2.5SD$). As shown in the figure, 91.4% of the osteoporotic patients have a Calscan T-score $\leq -1.8SD$ and 89% of the non-osteoporotic patients have a Calscan T-score $> -3.5SD$.

Table I. — Calculation of the thresholds for the Calscan T-score

		Lower threshold Calscan T-score		Upper threshold Calscan T-score	
		$T \leq -3.5SD$		$T \leq -1.8SD$	
		Yes	No	Yes	No
DXA ^a $\leq -2.5SD^b$	Yes	17	18	32 (91.4%)	3
	No	8	65 (89%)	44	29

^a DXA : dual-energy X-ray absorptiometry.
^b This is the T-score measured using DXA, whereby osteoporosis is defined as a T-score $\leq -2.5SD$.

Table II shows the theoretical costs of osteoporosis screening with or without use of the Calscan. This table clearly shows that because of the relatively high purchasing costs of the Calscan, screening will only become cheaper if sufficient patients per year are screened for osteoporosis. More specifically, using the Calscan will make osteoporosis screening cheaper if the number of patients screened for osteoporosis each year exceeds 200.

Table II. — Comparison of costs of DXA^a and Calscan

	100 ^b		200 ^b		300 ^b	
	DXA	CALSCAN	DXA	CALSCAN	DXA	CALSCAN
year 1	7500	23525	15000	27050	22500	30575
year 2	15000	29300	30000	36350	45000	43400
year 3	22500	35075	45000	45650	67500	56225
year 4	30000	40850	60000	54950	90000	69050
year 5	37500	46625	75000	64250	112500	81875

This table shows the total costs in euro per year for screening on osteoporosis with DXA compared to the costs for screening on osteoporosis with the Calscan. These costs are expressed for a different number of patients screened every year.

^a DXA: dual-energy X-ray absorptiometry.

^b Number of patients screened on osteoporosis every year.

DISCUSSION

This study shows that the Calscan is a valid measuring instrument. We have shown that using the Calscan T-score we were able to correctly classify 53% of patients as either osteoporotic or non-osteoporotic.

In order to put the Calscan to use in osteoporosis screening, it is necessary to calculate thresholds. In the current study the values of these thresholds were -1.8SD and -3.5SD. Earlier studies have suggested that the value for the upper threshold should lie between -1.3 and -1.4SD and the value of the lower threshold between -2.7 and -3.2SD (8,10,20). This difference in threshold values can be explained by the fact that the patients in these earlier studies were, on average, younger than those in the current study. As patients get older, their mean BMD will go down. As a consequence, the values of the thresholds will also go down. A small clinical study in patients aged between 72 and 98 years found the value of the lower threshold to be -3.2SD (8). This has also been confirmed by a mathematical model which specifies that, at the age of 75, the value of the upper threshold should be -1.9SD and that of the lower threshold -3.2SD (9). The values of the thresholds calculated here are therefore similar to those found in other studies, provided they are corrected for age. However, since the thresholds for the Calscan used in this study were based on a relatively small study population, they cannot automatically be applied to all patients with a hip fracture. To this end, larger prospective studies are needed.

Another important finding in this study was that only 44% (147/331) of the patients ≥ 65 years with a hip fracture had been screened for osteoporosis, despite the fact that osteoporosis screening is a standard part of the care plan for patients with such a fracture. Theoretically, this percentage could rise to 70% or more if the Calscan were to be used for osteoporosis screening; after all, 53% could be correctly classified using the Calscan T-score and of the other patients 44% would be screened at the FP clinic. We were unable to reliably determine the reason why only 44% of patients were screened for osteoporosis. Apparently, 42% of patients did not show up to the appointment at the FP clinic or were mistakenly not given an appointment in the first place. For the other 58% of patients we could not discover the reason they were not seen at the FP clinic. One reason might be that this less mobile patient group experiences an extra visit to the clinic as being too burdensome. Another explanation might be that a DXA can only be carried out once patients are sufficiently mobile, resulting in a delay of several months before the scan. With such time having passed since the initial fracture, some patients will be less inclined to appreciate the benefit of osteoporosis screening.

A theoretical advantage of osteoporosis screening using the Calscan on the hospital ward is that, for 25% of patients, the diagnosis of osteoporosis can already be made during the hospital stay and anti-osteoporosis medication can be started immediately in this group of patients. This could well prove to be beneficial since the maximum effect of

anti-osteoporotic drugs is not reached until after three months and most successive fragility fractures occur within one year (2,22). In addition, it would appear possible to reduce the costs of osteoporosis screening using the Calscan for such screening. Prospective studies are needed to substantiate these advantages.

A limitation of this study is the possibility of a selection bias because DXA and Calscan were not performed during admission to the hospital, but in an outpatient setting at the FP Clinic. Therefore, only 108 of the 331 patients who should have been screened for osteoporosis were actually screened with both devices. However, because in most hospitals it is not possible to obtain a DXA-scan during admission to the hospital, because of logistic and patient related (for example : immobility) reasons, it is difficult to prevent this selection bias.

CONCLUSION

For the time being, DXA remains the golden standard for measuring BMD. However, despite well-organized osteoporosis care only 44% of patients were screened for osteoporosis. In this study we demonstrate that the Calscan appears to be a valid measuring instrument that could be used to increase the percentage of patients undergoing screening for osteoporosis to more than 70%. An additional advantage is that 25% of patients could be started on anti-osteoporosis medication during their hospital stay.

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REFERENCES

1. Assessment of fracture risk and its application to screening for postmenopausal osteoporosis. Report of a WHO Study Group, 1994, p 1-129. World Health Organization technical report series 843.
2. Informatorium medicamentorum. <http://www.knmp.nl>.
3. Kwaliteitsinstituut voor de gezondheidszorg CBO. Richtlijn Osteoporose en fractuurpreventie derde herziening. Alphen aan den Rijn : Van Zuiden Communications ; 2011. p 1-221.
4. Nationaal Kompas Volksgezondheid. 20 augustus 2008. Heupfracturen samengevat. <http://www.nationaalkompas.nl/gezondheid-en-ziekte/ziekten-en-aandoeningen/bewegingsstelsel-en-bindweefsel/heupfractuur/heupfracturen-samengevat/>.
5. National Osteoporosis Society. Position statement on the use of peripheral x-ray absorptiometry in the management of osteoporosis. Bath, UK : NOS, 2004.
6. Rijksinstituut voor Volksgezondheid en Milieu RIVM. Kosten van Ziekten in Nederland 2005. <http://www.kostenvanziekten.nl/>.
7. World Health Organization. International Classification of Diseases (ICD), version 2007. <http://www.who.int/classifications/icd/en/>.
8. Albertsson D, Mellstrom D, Petersson C *et al*. Hip and fragility fracture prediction by 4-item clinical risk score and mobile heel BMD : a women cohort study. *BMC musculoskeletal disorders* 2010 ; 11 : 55.
9. Blake GM, Chinn DJ, Steel SA *et al*. A list of device-specific thresholds for the clinical interpretation of peripheral x-ray absorptiometry examinations. *Osteoporos Int* 2005 ; 16 : 2149-56.
10. de Klerk G, van der Velde D, van der Palen J *et al*. The usefulness of dual energy X-ray and laser absorptiometry of the calcaneus versus dual energy X-ray absorptiometry of hip and spine in diagnosing manifest osteoporosis. *Arch Orthop Trauma Surg* 2009 ; 129 : 251-7.
11. Eastell R. Treatment of postmenopausal osteoporosis. *N Engl J Med* 1998 ; 338 : 736-46.
12. Folbert E, Smit R, van der Velde D *et al*. Multidisciplinary integrated care pathway for elderly patients with hip fractures : implementation results from Centre for Geriatric Traumatology, Almelo, The Netherlands. *Ned Tijdschr Geneeskde* 2011 ; 155 : A3197.
13. Hegeman JH, Willemsen G, van Nieuwpoort J *et al*. Effective tracing of osteoporosis at a fracture and osteoporosis clinic in Groningen ; an analysis of the first 100 patients. *Ned Tijdschr Geneeskde* 2004 ; 148 : 2180-5.
14. Lips P, van Schoor NM. Quality of life in patients with osteoporosis. *Osteoporos Int* 2005 ; 16 : 447-55.
15. Marshall D, Johnell O, Wedel H. Meta-analysis of how well measures of bone mineral density predict occurrence of osteoporotic fractures. *BMJ* 1996 ; 312 : 1254-9.
16. Nakamura T, Liu JL, Morii H *et al*. Effect of raloxifene on clinical fractures in Asian women with postmenopausal osteoporosis. *J Bone Miner Met* 2006 ; 24 : 414-8.
17. Saltzher TP, Borghans HJ, Bakker RH *et al*. Proximal femur fractures in the elderly in The Netherlands during the period 1991-2004 : incidence, mortality, length of hospital stay and an estimate of the care capacity needed in the future. *Ned Tijdschr Geneeskde* 2006 ; 150 : 2599-604.

18. **Stone KL, Seeley DG, Lui L Y et al.** BMD at multiple sites and risk of fracture of multiple types : long-term results from the Study of Osteoporotic Fractures. *J Bone Miner Res* 2003 ; 18 : 1947-54.
19. **Swanpalmer J, Kullenberg R.** A new measuring device for quantifying the amount of mineral in the heel bone. *Ann N Y Acad Sci* 2000 ; 904 : 115-7.
20. **Thorpe JA, Steel SA.** The DXL Calscan heel densitometer : evaluation and diagnostic thresholds. *Br J Radiol* 2006 ; 79 : 336-41.
21. **Tosteson AN, Gabriel SE, Grove MR et al.** Impact of hip and vertebral fractures on quality-adjusted life years. *Osteoporos Int* 2001 ; 12 : 1042-9.
22. **van Helden S, Cals J, Kessels F et al.** Risk of new clinical fractures within 2 years following a fracture. *Osteoporos Int* 2006 ; 17 : 348-54.
23. **van Helden S, Cauberg E, Geusens P et al.** The fracture and osteoporosis outpatient clinic : an effective strategy for improving implementation of an osteoporosis guideline. *J Eval Clin Pract* 2007 ; 13 : 801-5.