Screening for diabetic foot and osteoporosis in Bulgaria

Hripsime Bohchelian, Dimiter Dimitrov, Lidia Koeva

Article points

1. Osteoporosis can be associated with both type 1 and type 2 diabetes.
2. Early screening should form part of the health care program for those with diabetes.
3. Applied screening reveals a high frequency of diabetic foot and osteoporosis risk factors among people with diabetes.
4. More research needs to be done to investigate the relationship between osteoporosis and the diabetic foot.

Key words

- Screening
- Osteoporosis

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Both osteoporosis and the diabetic foot pose significant social problems. Both conditions lead to serious complications in their later stages and both need early diagnosis which makes treatment much more effective, reduces the socio-economic impact and outcomes improved. Together with other possible factors such as genetic factors, calcium intake and levels of physical activity, diabetes itself could play an additional role in the diminution of bone mineral density (Gregorio et al, 1994; Kayath et al, 1994). Of practical significance is the high frequency of osteoporosis among young people with diabetes where osteoporosis, because of advanced age, is excluded.

Type 1 diabetes has long been associated with low bone density (Strotmeyer et al, 2006). However, it was unclear until recently whether this translated into increased fracture rates. Results from the Nord-Trondelag Health Survey from Norway showed a significant increase in hip fracture rates among female participants with type 1 diabetes (relative risk 6.9, confidence interval 2.2–21.6) compared to females without diabetes (Forsen et al, 1999).

The mechanism of bone loss in type 1 diabetes is still unknown, although several theories exist based on animal and cellular models. Insulin-like growth factors and other cytokines may influence metabolism in the bones of people with diabetes (Bouillon, 1991). Diabetic retinopathy, advanced cortical cataracts and diabetic neuropathy have all been associated with increased fractures (Ivers et al, 2001; Piepkorn et al, 1997). These are also risk factors for increased falls due to visual impairment and alterations in balance and gait. For people with type 1 diabetes, the initial onset of the disease often occurs at a young age when bone mass is still being accrued. Thus, low bone mass would seem a likely complication of type 1 diabetes in adulthood.

Type 2 diabetes was previously believed to provide protection against osteoporosis because of its association with normal-to-increased bone mineral density (BMD; Isaia et al, 1999). This theory was primarily based on the concept of BMD alone and predominantly not from prospective controlled large trials. When considering all risk factors, people with diabetes generally have an increased risk of falling because of peripheral neuropathy, possible hypoglycaemia, nocturia and visual impairment. In a large prospective study of older women obtained from the Study of Osteoporotic Fractures, Schwartz et al (1997) confirmed that women with type 2 diabetes

Page points

1. Prevention and treatment of osteoporosis diminishes fracture risk.
2. Early treatment of the diabetic foot is widely known to be a highly effective method of preventing foot ulceration and amputation.
3. In this study, all participants underwent a clinical and instrumental examination.
4. The authors carried out a screening study with the following aims: to identify high risk individuals for diabetic foot and to investigate the frequency of diabetic foot and osteoporosis.

experience higher fracture rates in regions of the hip, humerus and foot than women without diabetes. Bone loss has been observed to be greater in people with poorly controlled diabetes than in those whose diabetes is well controlled (Gregorio et al, 1994).

Prevention and treatment of osteoporosis diminishes fracture risk and early treatment of the diabetic foot is widely known to be a highly effective method of preventing foot ulceration and amputation (Boulton, 1995; Jones et al, 1995; Stuck et al, 1995; Armstrong et al, 1996; Barrett-Connor et al, 1992; Barzel, 1996). The first step towards prevention is the early identification of risk factors associated with fractures and diabetic foot complications (Boulton et al, 2005). In connection with this, the authors carried out a screening study with the following aims: to identify high risk individuals for diabetic foot and to investigate the frequency of foot problems and osteoporosis among members of Varna's Diabetic Association.

Materials and methods

The participants involved in this study were 141 members of the Diabetic Association in Varna, Bulgaria, with type 1 or type 2 diabetes.

There were 20 patients with type 1 diabetes (11 women, 9 men), mean age 31.3 ± 9.2 years and 121 patients with type 2 diabetes (54 women, 67 men), mean age 58.3 ± 6.2 years.

Ethics

The study was approved by the local ethical committee in accordance with the Helsinki-II declaration. All participants signed informed consent forms agreeing to participate in the study.

Table 1. Basal clinical characteristics of the investigated participants (n = 141).

Characteristics	Type 1 diabetes	Type 2 diabetes
Men	9	67
Women	11	54
Mean age	31.3 ± 9.2 years	58.3 ± 6.2 years

Methods

All participants underwent a clinical and instrumental examination. HbA_{1c}, pedal pulses (*a.dorsalis pedis* and *a.tibialis posterior*), Doppler ankle/brachial pressure index, protective pressure sensation to a 10 g monofilament, vibration perception measured by 128 Hz tuning fork and BMD by Osteometer DTX-200 were examined.

Legs were examined for foot deformity, weakness of the small muscles of the foot, prominence of the metatarsal heads, Charcot foot, dry skin, hyperkeratosis, callus formation, mycosis, foot oedema and foot lesion (in cases of foot lesions Wagner classification was used to further define the degree of the condition). Osteopaenia and osteoporosis were defined on the basis of T-score according to the WHO working group criteria (Edmonds and Watkins, 1992). The WHO define normal bone density as within one standard deviation of the young adult mean (T score > –1). Osteopaenia is defined by a T score between -1 and -2.5. Osteoporosis is defined as a T score of less than -2.5 (National Osteoporosis Foundation, 2003).

Student *t*-test and analysis of relative risk after Maentel-Haenszel (Chi squared) were applied.

Results

The clinical characteristics of the participants are presented in *Table 1*. The authors recorded the prevalence of pathologic conditions the frequency of newly diagnosed cases with diabetic macroangiopathy (DMA), diabetic peripheral neuropathy (DPN) and osteoporosis (*Table 2, Table 3*).

Screening reveals DMA in 32% of participants (newly diagnosed in 48%), DPN in 50% (newly diagnosed in 20%), osteopaenia in 41% (newly diagnosed in 100%) and osteoporosis in 23% (newly diagnosed in 90%) (*Table 3, Figure 1*). In two participants, foot ulcerations were established; neuropathic foot ulcer on the forefoot in one of the cases, neuroischaemic foot ulcer in the second case. Both ulcers were described as grade II after Wagner classification. There was

Table 2. Prevalence of pathologic conditions found during screening.

Pathology	n	%†	95 % confidence interval
Diabetic polyneuropathy	71	50	48.2–52.7
Diabetic macroangiopathy	45	32	30.1–34.5
Osteopaenia	58	41	39.5–43.4
Osteoporosis	32	23	20.1–25.2
Callus formation	76	47	45.2–49.4
Foot deformity	23	16.3	15.2–18.1
Atrophy of small foot muscles	6	4.3	3.3–5.7
Clawing of the toes	4	2.8	1.6–3.9
Prominence of metatarsal heads	5	3.5	2.8–4.9
Charcot foot	8	5.7	4.5–7.1
Dry skin	76	53	51.3–55.4
Hyperkeratosis	37	26	23.4–28.5
Mycosis	36	28.5	27.1–29.6
Foot oedema	11	8	6.2–10.4

† *Overall percentage exceeds 100 % due to combined pathologies in the majority of patients.*

Table 3. Effect from the screening; pathological conditions and relative proportions of new cases.

Pathology	Total cases (n=141)		Known diagnosis		New diagnosis	
	n	%	n	%	n	%
Diabetic polyneuropathy	71	50	57	80	14	20
Diabetic macroangiopathy	45	32	23	52	22	48
Osteopaenia	58	41	0	0	58	100
Osteoporosis	32	23	3	10	29	90
Foot ulcers	2	1.4	2	100	0	0

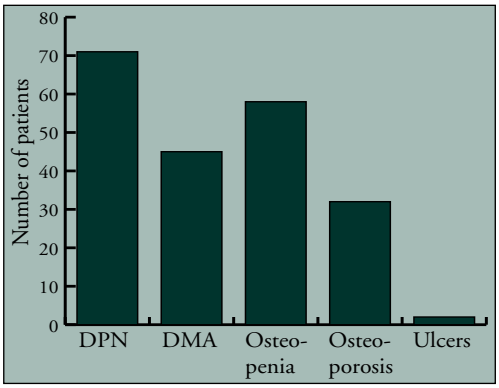

Figure 1. Pathological conditions established by screening.

a history of former healed neuropathic ulcer in one case and transmetatarsal amputation of foot in one case.

Discussion

The pathogenic background of foot ulceration and amputations is complex, but it is predominantly connected with diabetic polyneuropathy, peripheral macroangiopathy and foot deformity. Cases with such complications at initial diagnosis of diabetes are not rare (Mueller, 1996). With advancement of diabetes duration the number of cases with

Page point

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1. Screening for peripheral neuropathy is an easily applicable process that can be used to detect risk of diabetic foot.
2. Charcot foot is a destructive bone and joint process. After being identified it should become an object of specialised regular health care.
3. Osteoporosis and osteopaenia could be present together with diabetic foot The association of diabetic foot with osteoporosis is the basis for the implementation of BMD measurement.

chronic vascular complications increases. In the authors' opinion, the gradual onset of these conditions, underestimation of seriousness of the problems and lack of patient education are to blame for the delayed active search for medical help and late diagnosis. This is one of the reasons supporting the early identification of high risk people with diabetes.

There is substantial evidence that simple methods such as investigation into vibratory sensing of a 128 Hz tuning fork and pressure sensation to a 10 g monofilament can diagnose diabetic peripheral neuropathy and predict future ulceration (Wu and Armstrong, 2005). Vascular assessment by palpation of pedal pulses and Doppler ankle/brachial pressure index are highly useful for detecting the presence or absence of clinically manifested lower extremity arterial insufficiency (Han and Ezquerro, 2002). These methods are easily applicable and could be used as part of a screening for detection of diabetic foot risk factors. Identification of people at high risk would be facilitated and appropriate treatment initiated (Armstrong et al, 1996).

The present screening study uses simple but highly informative methods for diagnosis of diabetic foot. The results from the screening show a high frequency of diabetic polyneuropathy, macroangiopathy and a considerable part of newly diagnosed cases which confirm the practical significance of such a survey.

In 16.3% of people with diabetes, foot deformity is established during screening. This condition often precipitates foot ulceration, but is often underestimated (Abu-Omar, 2006). The relatively high proportion of people with diabetes who have a foot deformity highlights the need for further specialised foot care.

Screening has contributed to the identification of people at high risk for diabetic foot complications; such as those with diabetic neuropathy, macroangiopathy and foot deformity. Charcot foot is a destructive bone and joint process. After being identified it should become an object of specialised regular health care.

People with diabetes who have foot ulcers and who have undergone amputation have not participated regularly in the educational programme run by Varna's Diabetic Association. This is despite the important role that patient education plays in the overall care of the diabetic foot (Boulton, 1995).

Osteoporosis and osteopaenia could be present together with diabetic foot. The association of diabetic foot with osteoporosis is the basis for the implementation of BMD measurement as another basic objective in screening. The high frequency of osteopaenia and osteoporosis among the examined patients confirms the necessity of such a screening. Only three out of the 32 participants with osteoporosis knew about their diagnosis before the screening. In the remaining 29 cases (90%) osteoporosis was newly discovered by the screening. In 100% of cases with osteopaenia the diagnosis was newly discovered. This can be attributed to the character of osteopaenia pathology (which as no clinical symptoms) and to the specific requirements for diagnosis (not detected by X-ray, but by osteodensitometry). In 48% of cases with macroangiopathy and in 20% of cases with polyneuropathy, diagnosis was newly discovered.

Early screening and identification of people with diabetes at risk for osteoporosis should be part of their health care programme as it could help to avoid irreversible complications.

Screening for osteoporosis and diabetic foot complications should form part of an active approach to prevention. Secondary medical intervention as a response to patients' need for medical help takes place at a later stage of the disease and thus may not be as effective.

The established frequency of chronic diabetes complications and osteoporosis is similar to data from other studies (Piepkorn et al, 1997; Gregorio et al, 1994; Klenerman et al, 1996). The screening finds a high frequency of polyneuropathy, macroangiopathy, osteopaenia and osteoporosis among the investigated group. In a large proportion of these cases the condition has been newly identified. These results support the use of such screening, and that a screening for diabetic foot and osteoporosis is an essential part of diabetes

treatment as a whole. The advantages of the applied screening are as follows.

- It only takes a short period of time to carry out and thus can include a large number of people with diabetes.
- It uses available and simple techniques, such as examination of pedal pulses, vibration sensation, osteodensitometry.
- The process is repeatable and influential on the course of future treatment.
- Highly informative for the prevalence of diabetic macroangiopathy, polyneuropathy, osteoporosis and risk of foot ulceration.

Conclusion

Screening by simple, non-invasive methods reveals high frequency of diabetic foot risk factors and osteoporosis among members of Varna's Diabetic Association. It is a form of active prevention and identifies of high risk individuals. Screening for osteoporosis and diabetic foot complications should be considered an essential part prevention and the diagnostic programme in people with diabetes. Our study had some limitations, including the small number of participants – meaning the results may not be valid globally – but they do indicate that more research needs to be done on the relationship between osteoporosis and the diabetic foot. ■

Page points

1. Screening for diabetic foot and osteoporosis is an essential part of diabetes treatment as a whole.
2. More research needs to be done on the relationship between osteoporosis and the diabetic foot.

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