

THE INTRODUCTION OF A BONE DENSITOMETRY SERVICE

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There has been much recent publicity concerning osteoporosis resulting in increased awareness among doctors and the general public about the diagnosis and management of this condition, for which effective treatment is now available. The purchase of a DEXA scanner has provided Lancaster with a valuable means of identifying patients suffering from osteoporosis and assessing the response to specific treatment. The opportunity also exists to offer bone screening to those people who have specific high risk factors to identify those who would benefit from early preventative treatment. There is no intention to provide a population based screening programme, which has been the subject of considerable controversy in the national and medical press^{1,2,3} and which is the subject of two major ongoing research projects.

DEFINITION

Osteoporosis is a disease characterised by low bone mass, microstructural deterioration of bone tissue leading to enhanced bone fragility and a consequent increase in fracture risk.⁴ Osteoporosis refers to the reduction of bone density with or without fracture.

THE SIGNIFICANCE OF OSTEOPOROSIS

As osteoporotic bones are weaker than average the significance of osteoporosis is the predisposition to fractures at these principle sites:- vertebral bodies, wrists and hips. There are approximately 130,000 vertebral fractures a year, 40,000 wrist fractures, 50,000 hip fractures and 70,000 other fractures which may in part be related to osteoporosis. These fractures are an important cause of morbidity and mortality and have been estimated to cost the NHS £500 million per year. Hip fractures occupy 20% orthopaedic beds, have a mortality of 10-20% and cost approximately £165 million annually let alone the private and social costs to individuals. In view of the ageing population it has been estimated that within 20 years the expected number of osteoporotic hip fractures will have increased by 33% with a corresponding increase in wrist and vertebral fractures, unless preventative treatment is available. Osteoporosis causes greater mortality than carcinoma of the breast, uterus and cervix combined. The life time risk of a woman having an osteoporotic fracture is 30% compared with a life time risk of 9% for breast cancer.

This osteoporotic epidemic therefore poses one of the major health care issues of the 1990s, particularly as it represents a major claim on future health service resources.

RISK FACTORS AND CAUSES

Osteoporosis represents the end result of an imbalance between the process of bone resorption and bone formation. Factors that predispose to osteoporosis are those which induce a low peak bone mass and those that cause excessive post menopausal and ageing-associated bone loss.

Genetic, nutritional, lifestyle and endocrine factors are known to affect both the peak bone mass and also the rate of subsequent bone loss (Table 1).

TABLE 1 - RISK FACTORS FOR OSTEOPOROSIS

Risk Factors	Effects on development of osteoporosis
Early menopause	Oestrogen protects against bone loss
Parity	Women have a greater risk if they are nulliparous
Race	Black people have a higher skeletal mass and lower incidence of osteoporosis than whites and asians
Family History	Women with a family history of postmenopausal osteoporosis are at increased risk of osteoporosis
Body Build	Obesity protects against osteoporosis by increasing the amount of available oestrogen. New bone formation results from additional stress on bones
Immobility	Immobility and prolonged bed rest leads to decreased bone mass
Low Calcium diet	Calcium is essential for bone formation
Smoking	Women who smoke have lower body weights and earlier menopause than non-smokers
Alcohol	Heavy alcohol consumption leads to a decline in bone mass and an increased risk of falling
Corticosteroid therapy	Corticosteroids decrease bone formation and increase bone resorption

In this multifactorial disease the identification of an at risk population is complex because risk factor analysis has been applied only to those with overt disease and not asymptomatic individuals. However, it has been suggested that the overall risk is proportional to the number of risk factors present and to the length of time the individual has been exposed to them.

The accelerated bone loss that occurs around the menopause is predominantly due to oestrogen deficiency and rate of bone loss varies from 1-5% per year for the next 10 years. Those women who lose more than 5% bone mass per year ('fast bone losers') represent 25-30% of the female population and are especially vulnerable to osteoporotic fractures in the future. It is well established that women with

lower bone density measurements have weaker bones and are at greater risk of fracture. Studies have estimated that the risk of fracture increases by 30-70% as bone density falls by one standard deviation.

In addition various diseases and conditions are known to cause generalised osteoporosis (Table 2) of which prolonged immobility and corticosteroid use are of major importance.

TABLE 2 – CAUSES OF GENERALISED OSTEOPOROSIS IN ADULTS

Age related
Post-menopausal
Immobilisation
Rheumatoid Arthritis
Hyperthyroidism
Primary hyperparathyroidism
Chronic liver disease
Drugs:–
Corticosteroids
Alcohol
Thyroxine

It is naive to consider that the risk of fracture is solely related to bone mass as other factors such as age, the frequency and severity of falls and protective neuromuscular defenses are all contributory. The role of falls differs with different types of fractures, as does the importance of protective neuromuscular defenses (Table 3).

TABLE 3 – RELATIVE IMPORTANCE OF SKELETAL AND NON-SKELETAL FACTORS IN VARIOUS OSTEOPOROTIC FRACTURES

Type of fracture	Role of falls	Role of bone
Wrist	+++	+
Hip	++	++
Vertebral	+	+++

METHODS OF BONE MASS MEASUREMENT

Until recently the only way to estimate the amount of bone mass was to perform serial x-rays of the spine and monitor the development of vertebral fractures. Conventional radiography is very insensitive as bone loss is only apparent when 30-50% of bone has been lost.

Over the past decade a variety of non-invasive techniques have been developed for the assessment and measurement of bone mass including single or dual photon absorptiometry, dual energy x-ray absorptiometry (DEXA) and quantitative computerised tomography. The DEXA system is currently the standard method for bone mass measurements in which the lumbar spine and hip are scanned using two energies of radiation that are absorbed by soft tissue and bone. The x-ray beam produces an image of the bones and the computer measures the area of bone under study. Bone mineral density (BMD) is expressed as grams of hydroxyapatite per cm². This result is then compared to results from age matched controls and also the mean for normal young subjects. (Figures 1 and 2). DEXA scanners provide rapid (less than 10 minutes), reliable and accurate bone mass measurements with a very low radiation dosage of less than one fifth of the daily background radiation.

The finding of osteopenia does not make a tissue diagnosis and other causes of low bone density should be excluded by appropriate investigation before a diagnosis of osteoporosis is accepted.

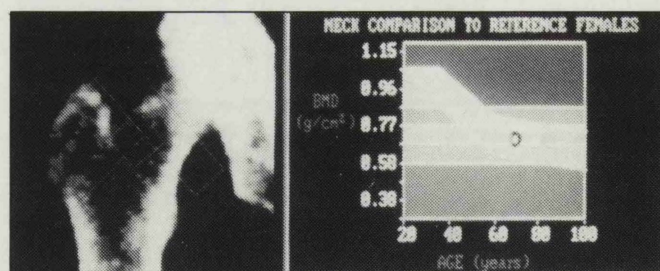


Fig 1 – DEXA scan result of a 70-year-old female's hip. (Within normal range of reference values)

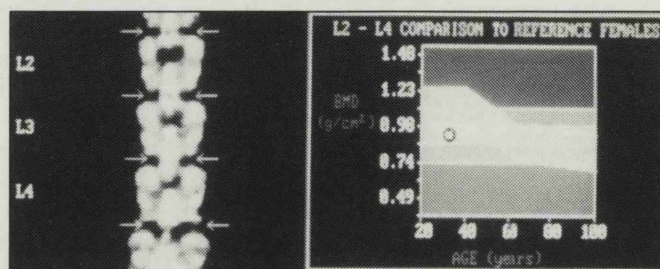


Fig 2 – DEXA scan result of a 32-year-old female's spine (L2-L4). (One standard deviation below the mean)

The Regional Health Authority has just purchased a DEXA scanner for the Rheumatology Department, which has made Lancaster the first district in the region to be given the opportunity to develop an open access service to assist in the diagnosis and management of osteoporosis.

HOW WILL THE BONE DENSITY SERVICE OPERATE?

The DEXA scanner is located at the Garnett Clinic in the EEG Department adjacent to the Rheumatology office and is staffed by a Senior Radiographer (Figure 3). An open access service for bone density measurements will be offered to hospital specialists and local G.P.s. The reasons for referral and clinical details should be indicated on a standard referral form. Self-referral by patients will not be accepted. When patients attend for scanning a short questionnaire will be administered to identify factors which may be associated with osteoporosis and educational information will be provided to increase bone



Fig 3 – The Lancaster DEXA Scanner

health awareness. Densitometry results will be sent to the referring doctor with an accompanying report.

No further action would be recommended for young females whose bone density is within the normal range used by the department. Females whose bone mineral density falls below 2 standard deviations of the mean for aged matched subjects should be investigated to establish the cause of osteopenia and/or a referral to the Rheumatology clinic considered. (These investigations should include a blood count and ESR, biochemical profile to include alkaline phosphatase, calcium and phosphate, thyroid function tests and immunoglobulins.)

If investigations confirm osteoporosis these high risk subjects should be actively considered for Hormone Replacement Therapy. For those patients in whom HRT is contraindicated or cannot be tolerated, referral to the clinic should be considered for alternative treatment. If the results are in the low normal range a repeat scan in 1-2 years time should be considered.

The aim of this service is to:-

1. Identify patients suffering from osteoporosis.
2. Provide measurements to monitor treatment efficiency.
3. Screen those women who have specific high risk factors for a fracture in later life.

1. Referrals would be particularly appropriate for those patients with medical conditions known to predispose to osteoporosis (Table 3) and those on long term corticosteroid therapy who have received >7.5 mgs Prednisolone daily for more than 6 months.

Patients under 60 years who have radiological evidence of osteoporosis or who have had a suspected osteoporotic fracture would also be offered scanning when treatment decisions would be influenced by bone mass measurements. When the radiological appearances of osteoporosis are so advanced a scan would not normally be considered necessary.

2. The availability of new treatments for osteoporosis means that for the first time an objective assessment of the response to treatment by bone mass measurement can be made.
3. Screening of women with specific high risk factors such as a premature menopause (age <45 years) or who have had bilateral oophorectomies at an early age should be considered in those who would be prepared to accept treatment with Hormone Replacement Therapy. Screening would also be offered to perimenopausal or post-menopausal women in whom bone mass measurements would influence a decision about HRT. Those women who would be concerned about the return of menses with HRT would be more likely to comply with treatment if it was established that they were at high risk of fracture.

MANAGEMENT OF OSTEOPOROSIS

Major advances in the management of osteoporosis have been made in the past two decades. In 1971 Prices Textbook of Medicine commented 'that he who sets out to treat osteoporosis should be modest in his ambitions'.

As osteoporosis is much easier to prevent than treat preventative means should be aimed at optimizing peak bone mass and also reducing the rate of subsequent bone loss. Bone mass at skeletal maturity can be optimised by regular exercise, an adequate diet including calcium and Vitamin D, and moderation or preferably abstinence from smoking and alcohol consumption. In females relative oestrogen deficiency such as late menarche, irregular menstruation and amenorrhoea minimizes the peak bone mass attainable. The most effective means of reducing the rate of bone loss in women is oestrogen therapy used either post-menopausally or in women with impaired ovarian function.

A variety of drugs is currently available for the prevention and treatment of osteoporosis (Table 4).

TABLE 4 – DRUGS USED IN THE TREATMENT OF OSTEOPOROSIS

Inhibitors of bone turnover	Stimulators of bone formation
Oestrogens	Fluoride
Calcitonins	Parathyroid hormone
Calcium	
Biphosphonates	
Anabolic steroids	

HORMONE REPLACEMENT THERAPY

Opinion about HRT varies between those doctors who 'do not believe in it' to those who consider that all women should be treated with HRT provided there are no medical contra-indications. The increased public awareness about the beneficial effects of HRT on the cardiovascular system skeleton and improving the quality of life has made this a major health care issue.

Oestrogen therapy is the drug of choice in preventing bone loss in women after the menopause. By inhibiting bone resorption oestrogen reduces or even temporarily reverses bone loss at all sites and the effects persist as long as therapy is continued.

The combination with progestogens, which is required to reduce the risk of uterine cancer, does not impair the response of the skeleton to oestrogen. It has been shown that 0.625 mgs of conjugated equine oestrogen daily, 2 mgs Oestradiol valerate or Oestradiol daily, the 50 µg transdermal patch and standard Oestradiol implant dosage are all effective in preventing bone loss in the majority of women.

Epidemiological data have suggested that oestrogen therapy given for at least 5 years in the climacteric period reduces subsequent hip and wrist fractures by about 50% and vertebral fractures by up to 90%.

HRT is conventionally recommended for a maximum of 10 years, although how long the protective effect of HRT persists remains to be determined by prospective studies. However the current evidence of a 50% reduction in fracture incidence is compelling evidence for the benefits of HRT in the skeleton.

In addition to the beneficial skeletal effects of HRT various other positive and negative effects need to be taken into consideration in starting an HRT programme.

Oestrogen replacement therapy has been shown to reduce the risk of cardiovascular disease by about 50% and these benefits may exceed those to the skeleton. It is not known whether the addition of progestogens modifies this cardiovascular benefit. There is no agreement about any increase in the risk of breast cancer in women receiving oestrogen replacement therapy. Long term therapy may be associated with a small increase in the diagnosis of breast cancer but no increase in breast cancer deaths has been shown. As yet there is inadequate evidence to assess the effects of combined therapy in the risk of breast cancer.

One of the major negative effects of HRT and presumably the main reason for poor compliance is the return of menstrual bleeding. If it is established that the recently introduced Tiborone (Livial) reduces the rate of bone loss this product may be a more acceptable alternative to patients, but at a considerably higher cost.

CALCIUM SUPPLEMENTS

The importance of an adequate calcium diet at all stages of life is well established. A recent study found that an adequate supply of dietary calcium up to the age of 30 was more important in preventing osteoporosis than calcium later. Whilst there is some evidence to suggest that calcium supplements will slow down the rate of bone loss in postmenopausal women the role of calcium in the prevention or treatment of osteoporosis is uncertain. Calcium supplements are more expensive than some HRT preparations and are no substitute for reducing post menopausal bone loss. A minimum intake of 800 mgs of calcium daily is recommended for all adults, higher amounts (1000 mgs – 1500 mgs) are required in children, pregnancy, lactation and old age.

FLUORIDE

Fluoride therapy is effective in increasing trabecular bone mass in patients with severe vertebral osteoporosis. But the effect on the incidence of fracture is controversial and in view of the possible increase in non-vertebral fractures the results of further studies are awaited before fluoride can be recommended.

CALCITONIN

Calcitonin may be considered in the prevention of osteoporosis in women at high risk for whom HRT is contraindicated. While Calcitonin may be effective in reducing bone loss in patients with established osteoporosis there is no conclusive evidence to suggest a reduction in the vertebral fracture rate. The need to administer treatment by injection and the high cost are major disadvantages. It remains to be established what role intra-nasal calcitonin has in the prevention and treatment of osteoporosis.

BIPHOSPHONATES

Biphosphonates are potent inhibitors of bone resorption and have been used successfully for many years in the treatment of Paget's disease and hypercalcaemia. As a result of two well controlled trials, which showed that disodium etidronate increased bone mass and significantly

reduced the vertebral fracture rate, Didronel PMO has just been launched. This non-hormonal preparation which is relatively free from side effects represents a major advance in the treatment of established vertebral osteoporosis. Further trials are under way to establish whether Biphosphonates have a role in prophylaxis and also the effect on non-vertebral fractures.

CONCLUSION

From an economic and health standpoint the most effective treatment for osteoporosis is primary prevention and preventative therapy. The major importance of health education has been stressed in an Office of Health Economics publication¹ and the major role of general practitioners and the primary health care team emphasised in the identification of women at high risk of osteoporosis and prescription of preventative treatment.

The provision of a local bone densitometry service has provided a major advance in the identification of patients suffering from osteoporosis and also a valuable means of identifying those high risk patient groups who would benefit from preventative treatment.

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FURTHER READING

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Helpful educational material for patients can be obtained from:- The National Osteoporosis Society, PO Box 10, Radstock, Bath BA3 37B.