PAPERS AND SHORT REPORTS

Corticosteroids and bone mass in asthma: comparisons with rheumatoid arthritis and polymyalgia rheumatica

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Abstract

Bone mass has previously been shown to be reduced at peripheral bone sites in patients with bronchial asthma receiving corticosteroids. To assess whether total bone mass is reduced in asthma total body calcium was measured by in vivo neutron activation analysis in patients receiving various treatments for asthma and compared with results from normal controls and patients with rheumatoid arthritis and polymyalgia rheumatica. Compared with controls total body calcium was reduced by 13·6% ($p<0·001$) in patients with asthma receiving daily oral corticosteroids but by only 9·0% ($p<0·005$) in a similar group of patients who had received oral calcium supplements at the start of their corticosteroid treatment. Total body calcium was also reduced in a group of patients receiving only inhaled corticosteroids (8·8%; $p<0·001$) but not significantly reduced in a small group of patients with asthma who had never received these drugs. When compared with controls a group of patients matched for age and for dose of corticosteroids given for rheumatoid arthritis had a similar reduction in total body calcium to the patients with asthma receiving daily oral treatment (17·7%; $p<0·001$), but no such reduction was shown in patients with polymyalgia rheumatica.

These findings suggest that the risk of bone loss with low dose oral corticosteroids is similar in asthma and rheumatoid arthritis. Further work is required to assess the clinical relevance of small losses of bone associated with the use of inhaled corticosteroids.

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Introduction

Since Cushing's original description of the syndrome in 1932 it has been recognised that supraphysiological concentrations of endogenous corticosteroids are associated with excess bone loss.[1] The introduction of cortisone as a therapeutic agent was followed very shortly by case reports of spontaneous fractures during treatment,[2] and subsequently radiological osteoporosis was reported at various skeletal sites.[3,4] The cause of corticosteroid induced osteoporosis is now better understood[5] but there remains controversy about the dose and duration of treatment with synthetic corticosteroids necessary to induce osteoporosis.[6-8] Whether or not bone loss can be prevented by altering the route or timing of drug administration[8,9] remains uncertain. There is also continuing controversy whether patients with some diseases may be less susceptible.[10-13]

As there is a relative paucity of data on bone mass in asthmatics we have carried out measurements of total body calcium in groups of patients with bronchial asthma treated with oral and inhaled corticosteroids and compared the results with those in people who have not received steroids. The results were also compared from those from patients with rheumatoid arthritis and polymyalgia rheumatica receiving regular oral corticosteroid treatment and from controls matched for age and sex.

Patients and methods

We measured total body calcium in 70 patients with asthma (28 men, 42 women). The total group was subdivided according to current and previous treatment. Group 1 consisted of 23 patients (eight men, 15 women) who were receiving regular oral corticosteroids and had been doing so for at least two years. Group 2 consisted of a further 13 patients (two men) who were also receiving regular oral corticosteroids but who had received oral calcium supplements as calcium lactate gluconate three tablets a day (elemental calcium dose 1·2 g daily) at the start of their corticosteroid treatment and for two to 20 years thereafter. Group 3 consisted of 22 patients (11 men) whose only regular corticosteroid treatment was given by the inhaled route either as beclomethasone 100 μg four times daily or as betamethasone 200 μg four times daily. Sixteen patients (six men) in group 3 had also received a mean of 2·2 booster courses of oral corticosteroids, usually beginning with 40 mg prednisolone daily and reducing to nothing over seven to 10 days. Group 4

consisted of 12 patients (seven men) who had never received corticosteroids either by inhalation or by the oral route.

The results from the four groups of patients with asthma were compared with those from 40 controls (20 men).[14,15] The results from patients in group 1 were further compared with those from 27 patients (eight men) with definite or classical rheumatoid arthritis,[16] matched for daily dose of prednisolone, and 12 patients (3 men) with polymyalgia rheumatica[17] who were receiving similar daily doses of oral corticosteroids.

All patients and controls who had abnormalities of calcium biochemistry or medical conditions known to be associated with secondary osteoporosis were excluded.

The corticosteroid dose for each patient was calculated retrospectively from the case records, supplemented when necessary by information from the patient. The total dose prescribed was expressed as the daily dose of prednisolone or equivalent averaged over the duration of treatment. Data on booster courses of the drugs were taken both from the case records and by direct questioning of the patient.

Total body calcium was measured by in vivo neutron activation analysis using the Edinburgh Medical Research Council cyclotron. Patients were irradiated with neutrons for 40 seconds while standing in a rigid polyethylene activation enclosure. Patients were then transferred to a shadow shield whole body counter, where γ radiation induced by the reaction calcium-48 (n, γ) calcium-49 was measured for 20 minutes. The patient's total body calcium was calculated in grams by comparison with the energy spectrum from an activated anthropomorphic phantom of human dimensions containing a known quantity of calcium. Repeated measurements of the phantom gave a long term precision of 1·8% for a radiation dose of 13 mSv (1·3 rem).[14] Normalisation was carried out by expressing individual results as a percentage of the expected normal value for the patient's skeletal size (arm span) in both sexes and menopausal state in women.[14] The in vivo precision of the technique was 2·9%.[18]

Statistical methods—Results were analysed by Student's *t* test for unpaired variables. The Mann-Whitney test was used for data not normally distributed and for small samples. By using Chauvenet's criterion[19]—a statistical technique designed to eliminate extreme values considered to occur by chance—two grossly aberrant total body calcium values from a woman in each of groups 1 and 2 were removed, leaving a total of 68 patients with asthma, whose results are reported.

Results

Table I gives details of age, duration of disease, corticosteroid and oral calcium treatment, and total body calcium values in grams in the four groups of patients with asthma. Patients in group 4 were significantly younger

TABLE I—*Sex ratio, mean age, years postmenopausal, duration of disease, and treatment in patients with asthma. (Mean values expressed with 1 SD in parentheses)*

	Group 1 (steroids alone; n=22)	Group 2 (steroids + calcium; n=12)	Group 3 (inhaled steroids; n=22)	Group 4 (no steroids; n=12)
Sex ratio (M:F)	8:14	2:10	11:11	7:5
Age (years)	54·1 (11·7)	60·8 (8·2)	55·6 (12·5)	37·9 (10·4)
No of women pre-/postmenopausal	6/8	1/9	3/8	4/1
Years postmenopausal	5·0 (7·3)	11·4 (9·7)	10·0 (8·2)	0·5 (1·1)
Duration of disease (years)	23·3 (18·1)	30·6 (13·3)	15·8 (16·3)	12·0 (15·2)
Steroid dose (mg/day)	6·8 (1·9)	8·9 (1·4)	—	—
Duration of steroid treatment (years)	12·5 (6·4)	18·0 (3·8)	—	—
No of boosters [range]	—	—	2·2 [0-18]*	—
Duration of calcium treatment (years)	—	10·6 (6·8)	—	—
Total body calcium (g)	863 (173)	787 (151)	894 (160)	1029 (116)

*Only 16 patients in group 3 given booster courses.

($p<0·001$) than those in the three other groups. Duration of disease was greater in group 2 than in group 3 (by 14·8 years; $p<0·05$) and group 4 (by 18·6 years; $p<0·01$). Patients in group 1 had received a lower dose of prednisolone (by 2·1 mg/day; $p<0·01$) and for a shorter period (by 5·5 years; $p<0·05$) than those in group 2. Prenormalisation values for total body calcium in controls were 1142·7 (1SD 133·8) g for men and 820·5 (124·7) g for women, as previously reported.[14]

Comparison of normalised results obtained in the control and asthma groups (fig 1) showed a reduction in mean total body calcium in group 1 (13·6%; $p<0·001$), group 2 (9·0%; $p<0·005$), and group 3 (8·8%; $p<0·001$). There was also a significant difference in mean total body calcium between groups 1 and 4 (8·1%; $p<0·05$). No significant differences were found between men and women.

No correlations were shown between the duration of disease and total body calcium in any of the four groups with asthma nor between the duration of calcium treatment and total body calcium in patients in group 2.

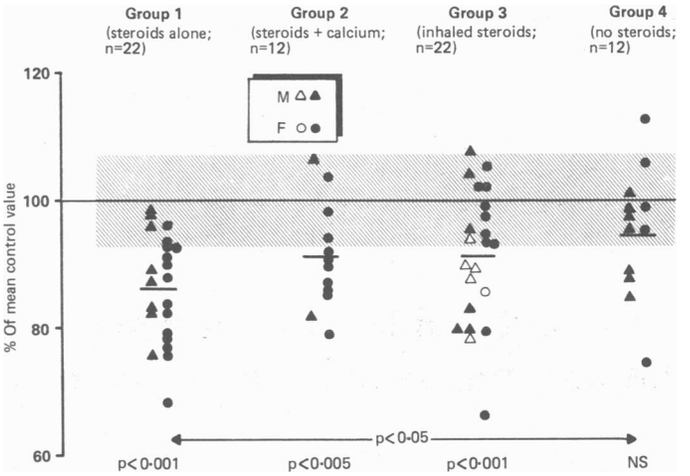

FIG 1—Total body calcium of patients with asthma expressed as percentage of mean of control population. Shaded area represents normal values (mean and 1 SD). In group 3 open symbols represent patients never given oral corticosteroids. Bars are means.

TABLE II—*Sex ratio, mean age, years postmenopausal, and details of corticosteroid treatment in controls and patients with asthma, rheumatoid arthritis, and polymyalgia rheumatica. (Mean values expressed with 1 SD in parentheses)*

	Controls (n=40)	Asthma (n=22)	Rheumatoid arthritis (n=27)	Polymyalgia rheumatica (n=12)
Sex ratio (M:F)	20:20	8:14	8:19	3:9
Age (years)	56·0 (7·5)	54·1 (11·7)	52·0 (11·8)	58·7 (10·2)
No of women pre-/postmenopausal	2/18	6/8	7/12	1/8
Years postmenopausal	8·8 (6·7)	5·0 (7·3)	6·8 (7·3)	11·8 (7·1)
Steroid dose (mg/day)	—	6·8 (1·9)	6·6 (1·9)	7·7 (1·5)
Duration of steroid treatment (years)	—	12·5 (6·4)	5·1 (4·4)	3·7 (3·3)
Total body calcium (g)	982 (206)	863 (173)	761 (155)	822 (173)

Table II gives details of sex ratio, age, corticosteroid treatment, and total body calcium values in group 1 patients with asthma and patients with rheumatoid arthritis and polymyalgia rheumatica. No significant differences were found between the patient groups with regard to age or corticosteroid treatment except that the patients with asthma had received oral steroids for longer than the patients with rheumatoid arthritis (7·4 years; $p<0·001$) and polymyalgia rheumatica (8·8 years; $p<0·001$).

Comparison of normalised results in these three groups with controls showed a reduction in mean total body calcium in patients with rheumatoid arthritis (17·7%; $p<0·001$) but none in those with polymyalgia rheumatica (fig 2). Compared with the group with polymyalgia bone mass was reduced in the patients with asthma (13·2%; $p<0·02$) and rheumatoid arthritis (17·3%; $p<0·001$). The apparent difference in mean total body calcium between the patients with asthma and those with rheumatoid arthritis did not reach statistical significance ($0·1>p>0·05$).

The reduction in total body calcium was not related to the duration of treatment or the total steroid dose (daily dose × duration) in any of the groups but was correlated with the mean daily dose of prednisolone in those patients with rheumatoid arthritis ($r=-0·605$; $p<0·001$).

Discussion

Oral corticosteroid treatment has previously been associated with reduced bone mass in patients with bronchial asthma.[8-10] These

studies compared treated patients with normal controls using different measurements of forearm bone mass. Though unlikely, the possibility that bone mass might be reduced in asthma as a consequence of the disease itself was not considered. As bones contain 99% of the body's calcium content[20] it is a reasonable assumption that total body calcium is a measurement of total bone mass, particularly as it is extremely well correlated with the total bone mineral content of the skeleton measured by dual photon absorptiometry.[21] Hence this study confirms that reduced total bone mass does occur in patients with bronchial asthma treated with daily oral corticosteroids (group 1) when compared both with age matched normal controls and with young asthmatics who had never received steroids (group 4). Though this latter group was significantly younger than the controls, other studies have failed to show a relation between total body calcium and age in men or premenopausal women,[14] suggesting that the loss of bone in group 1 was attributable to steroid treatment rather than to age or disease.

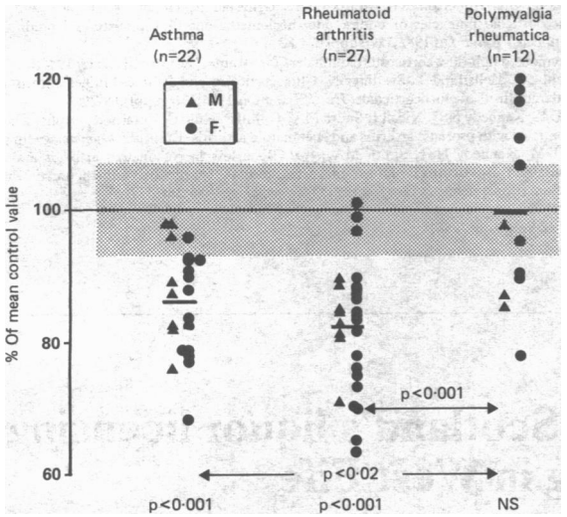

FIG 2—Total body calcium of patients receiving corticosteroid treatment expressed as percentage of mean of control population. Shaded area represents normal values (mean and 1 SD). Bars are means.

The reduction in mean total body calcium of 13·6% in group 1 was substantial. Postmenopausal patients with crush fractures have a mean reduction in total body calcium of 16-20%,[22-24] suggesting that many patients with asthma treated with steroids are at risk of osteoporotic fractures. Indeed two patients in group 1 had sustained at least one atraumatic crush fracture before the measurement of total body calcium and a further patient had recurrent problems with multiple rib fractures.

Prevention of corticosteroid induced osteoporosis in patients with asthma, rheumatoid arthritis, and other diseases remains a severe therapeutic problem.[5] The use of alternate day corticosteroid regimens has not been shown to be advantageous.[9 10] In this study five patients in groups 1 and 2 who had received an alternate day regimen of corticosteroids for the first two to five years of treatment had a total bone mass which did not differ from that of patients who had received continuous daily treatment.

Despite higher daily doses and a longer duration of corticosteroid treatment a small group of patients (group 2) who had received oral calcium supplements at the start of treatment had a slightly greater mean total body calcium than those in group 1 (4·6%; $0{\cdot}1>p>0{\cdot}05$). This suggests that the use of oral calcium supplements alone given at the start of corticosteroid treatment should be further investigated as a possible means of preventing osteoporosis. Other studies aimed at overcoming the calcium malabsorption known to be associated with corticosteroid treatment[25] have shown some benefit with 25-hydroxy vitamin D[26] but not with 1,25-dihydroxy vitamin D.[27]

The use of inhaled corticosteroids in asthma is almost certainly associated with a reduction in systemic side effects compared with oral treatment[28 29] but suppression of the hypothalamic-adrenal axis may occur with large doses.[30-32] There is little doubt that the main portion of the aerosol dose is deposited in the mouth and swallowed,[33] allowing gastrointestinal as well as pulmonary absorption. The finding that total body calcium was reduced in patients in group 3 by a mean of 8·8% compared with controls is therefore of concern. Sixteen of the 22 patients had received booster courses of oral corticosteroids, and such intermittent treatment has been associated with minor reductions of bone mass in patients with asthma.[8] The six patients who had never received oral treatment, however, had some of the lowest individual values of total body calcium (fig 1). This suggests that inhaled corticosteroids might be at least in part responsible for the reduction in group 3. The widespread and increasing use of high dose corticosteroid inhalers[34] suggests that further studies of bone mass in patients so treated should be undertaken. The pending development of inhaled corticosteroids which have an improved topical to systemic ratio[33 35] should be encouraged.

The effects of corticosteroids on bone mass in patients with asthma, rheumatoid arthritis, and polymyalgia rheumatica were compared (fig 2). Both patients with asthma and those with rheumatoid arthritis had reduced bone mass compared with patients treated for polymyalgia rheumatica but we were unable to confirm previous studies,[11 12] including our own preliminary data,[13] which suggested that corticosteroid treated patients with rheumatoid arthritis were more susceptible to bone loss than patients with asthma treated with similar daily doses. This study shows a small reduction in mean total body calcium (4·3%) in steroid treated patients with rheumatoid arthritis compared with asthmatics. As we have previously shown that total body calcium is reduced by 5·0-6·8% in patients with rheumatoid arthritis who have never received corticosteroids,[15] this reduction in bone mass may be attributable to the effects of the disease process, which causes appreciable bone loss at peripheral sites.[36]

Total body calcium is inversely related to the daily dose of prednisolone in patients with rheumatoid arthritis ($r=-0{\cdot}605$; $p<0{\cdot}001$). This finding raised the hypothesis that corticosteroid induced bone loss might occur early in the course of treatment,[15] and a recent longitudinal study has lent support to this theory.[37] Lack of a similar relation between total body calcium and daily steroid dose in asthma may reflect the wider fluctuations in individual steroid doses in these patients.

The explanation for the normal bone mass in patients with polymyalgia rheumatica is not clear. Women with polymyalgia rheumatica were older than those in the two other groups and the magnitude of the corticosteroid induced bone loss may not be apparent because of the substantial yearly 1·5% correction after the menopause.[14]

At present there is little convincing evidence for increased or decreased susceptibility to corticosteroid induced bone loss in patients with asthma or rheumatoid arthritis, though the position in patients with polymyalgia rheumatica may require further studies including larger numbers of subjects.

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Association between liberalisation of Scotland's liquor licensing laws and admissions for self poisoning in West Fife

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Abstract

Data were collected prospectively on 2868 consecutive patients admitted for self poisoning between 1971 and 1982. Analysis showed a dramatic increase in the frequency of alcohol taken in association with self poisoning, in both sexes, after the liberalisation of Scotland's liquor licensing laws. This increase, however, did not appear to affect the severity of overdoses or the outcome.

Total admission rates for self poisoning increased with relaxation of the liquor licensing laws, and since overdoses associated with alcohol tend to occur at night these impose considerable strain on casualty departments and acute admitting units.

Introduction

The Clayson committee examined alcohol related problems in Scotland in 1972 and concluded that "licensing, a negative and restrictive process, can play only a strictly limited part in the control of alcohol misuse."[1] As a result of the committee's recommendations Scotland's liquor licensing laws were relaxed in December 1976, allowing bars to remain open for an extra hour in the evenings. The following year public houses were permitted to open on Sundays and some "all day licences" were granted.

The effects of these changes on alcohol related problems in Scotland have recently been examined.[2] No increase in death rates from cirrhosis and alcoholism was found compared with England and Wales. There was a fall in the incidence of public order offences related to alcohol since the law was changed in 1976. A lag phase, however, would be expected before the death rate from cirrhosis began to rise, and numbers of deaths from alcoholism are very small. Convictions for public order offences may reflect policing policies as much as alcohol consumption. These deficiencies have been highlighted and recommendations made to consider data which reflect alcohol consumption in the community more accurately.[3]

This study examines the frequency of alcohol intake associated with admissions for self poisoning during the six year periods before and after the change in the law and the effects of alcohol on the medical outcome of these episodes.

Present study and results

Milesmark Hospital serves a mixed urban and rural population of roughly 130 000. All patients aged 12 and over with self poisoning are admitted to the

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