Bone mass in nodal primary generalised osteoarthritis

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SUMMARY Previous studies of patients with primary osteoarthritis of the hip have suggested an increase in bone mass compared with control populations. Nodal primary generalised osteoarthritis is known to have a strong familial tendency. To test the hypothesis that this tendency might also lead to increased bone mass, total body calcium has been measured by in-vivo neutron activation analysis and cortical area calculated from measurements of metacarpal indices in 15 female patients with primary generalised osteoarthritis. The results have been compared with those from 12 healthy controls matched for age, menopausal status, and skeletal size. No significant differences were noted in the total body calcium or cortical area measurements between the 2 groups either before or after correction for skeletal size and menopausal status. No relationship was found between the grade of radiological osteoarthritis in the hand and either bone mass parameter. Bone mass would not appear to be an important factor in the aetiopathogenesis of nodal primary generalised osteoarthritis.

Osteoarthritis (OA) is not a single disease but rather a pattern of biomechanical failure of joints which may be secondary to a variety of disorders of bone or articular cartilage. Although most theories of the pathogenesis of OA are based on primary alterations in the articular cartilage,2 Radin et al.3,4 have suggested that the progressive wear of fibrillated articular cartilage seen in 'primary' OA results from stiffening of the subchondral bone. Clinical support for such a hypothesis comes from the observation that pathological changes of OA are unusual in femoral heads removed from patients with fractured necks of femur5 and that bone mass appears to be increased in patients with primary OA of the hip when assessed by measurements of metacarpal indices6 or photon absorptiometry.7

To examine this hypothesis further we have assessed bone mass in female patients with nodal primary generalised osteoarthritis by measuring total body calcium and metacarpal indices and comparing the results with controls matched for age, skeletal size, and menopausal status.

Patients and methods

Fifteen female patients with nodal primary

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Bone mass in nodal primary generalised osteoarthritis (PGOA) fulfilling the criteria defined by Kellgren and Moore9 and 12 asymptomatic healthy women matched for age, skeletal size, and menopausal status have been studied. Serum calcium, phosphate, alkaline phosphatase, and albumin were measured in all subjects by standard methods, and persons with abnormalities of calcium metabolism or medical conditions known to be associated with secondary osteoporosis were excluded.

Total body calcium (TBCa) was measured by in-vivo neutron activation analysis. Patients were irradiated for 20 seconds from front and rear, while standing in a rigid polyethylene activation enclosure, by means of neutrons from the Edinburgh Medical Research Council Cyclotron. The patients were then transferred to a shadow-shield whole-body counter, where the gamma radiation from calcium 46Ca induced from stable 44Ca by neutron capture, was measured for 20 minutes. The patient’s TBCa in grams was calculated 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). The mean TBCa ± 1 SD in the control population was 842.0 ± 142.7 g. Individual results were expressed both in grams and
as a percentage of the expected normal value for the
patient's skeletal size (arm span) and menopausal
status. After correction for arm span and menopausal
status the spread in the normal controls expressed as
the coefficient of variation was reduced to 6.3%.

Metacarpal indices were measured by a variation
of the technique described by Dequeker. A single
posteroanterior radiograph of the hands was taken at
a uniform 1 metre tube-to-film distance using non-
screen film. Morphometric measurements were per-
formed at the right 2nd, 3rd, and 4th metacarpals.
The length of each metacarpal was determined with a
millimetre rule, and the external diameter (D) and
the internal diameter (d) of the midshaft of the cortex
were measured to the nearest 0.1 mm by means of a
needle-tipped direct reading Vernier caliper. The
cross-sectional cortical area was then calculated from
the formula \( \pi/4 \) \((D^2 - d^2)\), but omitting \( \pi/4 \) by
convention. The final figure was expressed as a mean
of the 3 metacarpals. The precision of the technique,
evaluated from 2 radiographs take at daily intervals
in 10 young normal controls, was 2.0%. The mean
cortical area in the control population was 46.3 mm\(^2\),
with a range from 37.5 to 52.9 mm\(^2\).

The severity of radiographic osteoarthritic changes
at the distal and proximal interphalangeal joints of
each digit and at the carpometacarpal joint of the
thumb was graded from 0 to 4 according to the
criteria of the Atlas of Standard Radiographs. A
composite score was derived from the sum of the
changes in each of the above joints giving a possible
score of 0–80 considering both hands. All patients
gave informed consent, and approval was obtained
from local and national ethical committees.

Results

Details of age, menopausal status, span, height, and
osteoarthrosis score for patients and controls are
shown in Table 1. The results of TBCa and cortical
area in the 2 groups are shown in Table 2. The mean
TBCa in control and PGOA groups showed almost
identical values, both when expressed in grams and
when expressed as a percentage of the expected
normal values for the patient’s skeletal size and
menopausal status. Mean cortical area measurements
in the 2 groups again showed no significant difference.

Total body calcium was highly significantly corre-
lated with cortical area \( r = 0.722, p<0.001 \). TBCa
and cortical area were not correlated with the osteo-
arthrosis score \( \text{TBCa: } r = -0.289, \text{ cortical area: } r =
-0.173 \). There was no different in any of the indices
of bone mass between patients who had or had not
received nonsteroidal anti-inflammatory drugs.

Discussion

These studies suggest that there are no significant
differences in total bone mass (measured by TBCa)
or local bone mass (measured by cortical area) in
patients with PGOA compared with matched controls.
Statistical analysis of the data shows that mean
differences in TBCa normalised for skeletal size and
menopausal status \( \approx 7-2\% \) and cortical area \( \approx 9-9\%
would have been significant at the 95% level in
groups of this size.

Previous studies have only measured bone mass in
patients with primary osteoarthritis of the hip. Foss
and Byers first suggested that bone density
measured by metacarpal indices was increased in
patients with primary OA of the hip when compared
with age matched normal subjects, but data on the
skeletal size and extent of generalised osteoarthritis
in the patient group were not included. Roh et al. found
an increase in periosteal diameter (external
cortical diameter) and cortical area in primary OA of
the hip compared with an age matched normal range,
but the differences in females may well have been
attributable to increased skeletal size. More recent
studies have failed to confirm such increases in bone
density using measurements of cortical area and
cortical thickness or cortical area related to cross-
sectional area.

Table 1 Mean age, menopausal status, span, height and
osteoarthrosis score in patients with PGOA and controls;
range given in parentheses

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>PGOA ( n = 15 )</th>
<th>Controls ( n = 12 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>59.5</td>
<td>59-5</td>
<td>55-5</td>
</tr>
<tr>
<td>(47-68)</td>
<td>(46-65)</td>
<td></td>
</tr>
<tr>
<td>Years after menopause</td>
<td>8-5</td>
<td>6-9</td>
</tr>
<tr>
<td>0-20</td>
<td>(0-22)</td>
<td></td>
</tr>
<tr>
<td>Arm span (cm)</td>
<td>166-2</td>
<td>159-8</td>
</tr>
<tr>
<td>(155-183)</td>
<td>(150-175)</td>
<td></td>
</tr>
<tr>
<td>Height (cm)</td>
<td>162-2</td>
<td>156-5-170</td>
</tr>
<tr>
<td>(156-5-170)</td>
<td>(151-173)</td>
<td></td>
</tr>
<tr>
<td>Osteoarthrosis score</td>
<td>36</td>
<td>3</td>
</tr>
<tr>
<td>(11-64)</td>
<td>(0-9)</td>
<td></td>
</tr>
</tbody>
</table>

Table 2 TBCa expressed in grams and as a percentage of
normal and cortical area in PGOA patients and controls.
Mean values ± SD with the range given in parentheses

<table>
<thead>
<tr>
<th>TBCa in grams</th>
<th>PGOA ( n = 15 )</th>
<th>Controls ( n = 12 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>830±6-129-0</td>
<td>(590-2-1053-7)</td>
<td>842±142-7</td>
</tr>
<tr>
<td>TBCa–% or normal</td>
<td>99±5±11-5</td>
<td>100±6±31</td>
</tr>
<tr>
<td>(83-0-120-1)</td>
<td>(88-7-110-4)</td>
<td></td>
</tr>
<tr>
<td>Cortical area in mm(^2)</td>
<td>47±0±6-4</td>
<td>46±3±5-2</td>
</tr>
<tr>
<td>(36-1-56-0)</td>
<td>(37-5-52-9)</td>
<td></td>
</tr>
</tbody>
</table>
Photon absorptiometric methods have been used to estimate metacarpal and radial bone mineral content\(^7\)\(^8\) in patients with primary OA of the hip. The results have been conflicting: one study appeared to show an increase in bone mineral content of 13% at cortical and 23% at trabecular sites,\(^7\) one showed an increase at a trabecular site alone,\(^1\) and one showed no increase at either site.\(^1\)

There are several possible explanations for the differences shown in these studies. The use of a stick as support might cause an increase in local bone mass, and this was eliminated in only 2 of the studies.\(^7\)\(^8\) More important, patients and study groups have not been closely matched for skeletal size in any of the studies where increased bone mineral has been shown. In 2 of them the osteoarthrotic groups were indeed taller than the controls.\(^7\)\(^8\)

No previous studies have corrected for menopausal status. As it is recognised that bone loss in females occurs at a rate of 1·1%\(^4\)\(^5\) to 1·5%\(^4\) per annum after the menopause and at a much slower rate before (0·37%),\(^6\) the small changes in the bone mineral content of the skeleton shown in some of the above studies may simply be related to different menopausal status.

Our failure to show increased total skeletal bone mass in patients with PGOA makes it very unlikely that bone mineral content is important in the aetio-pathogenesis of this genetically determined condition. Nevertheless, these findings do not rule out the possibility of local increases in bone density in areas adjacent to affected joints, or very small increases in total bone mass.

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**References**

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