Calcium balance

1,25(OH)_2cholecalciferol

Intestine
Ca 1.0 g/day

Bone

Ca 0.5 g/day

ECF Ca

Kidney

Ca 0.8 g/day

Ca 0.2 g/day

Ca 9.8 g/day

Ca 10.0 g/day

Ca 1.0 Kg

Urine Ca 0.2 g/day

1,25(OH)_2cholecalciferol
Calcium regulation

Parathyroid glands

Increased calcium in blood

Parathyroid hormone

Bones

Calcium reabsorption

Kidneys

Calcium reabsorption

Vitamin D hydroxylation

Intestines

1,25 hydroxy-vitamin D

Calcium absorption
Vitamin D effects on PTH production

1,25(OH)₂cholecalciferol

Suppresses Gene transcription

Parathyroid Hormone (PTH)

Upregulates 1α hydroxylase

Increased Blood and Urine calcium

Increased GI calcium absorption

-ve

GI calcium absorption

Increased Blood and Urine calcium
Hyperparathyroidism (Hyper-PTH)

• Primary
  – Autonomous production of the hormone from 1-4 glands (1:100)

• Secondary
  – To calcium deficiency or to vitamin-D (and hence then calcium) deficiency

- PTH overproduced
  PTH causes calcium to be resorbed from the skeleton
  Which causes high calcium in the blood and kidney.
  High calcium causes symptoms!
  Very high calcium can be dangerous!
  Cure from operation on PTH gland

- Low vitamin D (sun and pilchards) and/or
  Low calcium intake
  Causes low calcium in blood
  PTH production is triggered
  PTH ‘raids’ skeleton for calcium.. ‘resets’ calcium

High calcium causes symptoms!
Very high calcium can be dangerous!
Cure from operation on PTH gland
FRACTURES OWING TO SKELETAL FRAGILITY SECONDARY TO PRIMARY HYPERPARATHYROIDISM, WHICH HERE IS ASSOCIATED WITH THE CONDITION CALCIUM PYROPHOSPHATE DIHYDRATE DEPOSITION DISEASE
Progressive effects of longterm hyperparathyroidism on long bones – either primary PTH overproduction or PTH response secondary to calcium and/or vitamin D lack
- from young guns to old timers

Young skeleton
Young gun!

Rigid, thick cortical shell enveloping a trabecular structure and bone marrow

Midlife skeleton
Midlife crisis!

Endocortical resorption reduces the thickness of cortex. The inner cortical (lamellar) bone becomes more trabecularised

Old skeleton
Old timer!

Very thin cortical width Implying fragility for this structure, despite relative preservation of inner trabeculae
Forearm Bone Mass in Hyperparathyroidism

Proportionately lower on T and Z scores compared with BMD results for spine and hip

<table>
<thead>
<tr>
<th>Date</th>
<th>Scan Area</th>
<th>BMD Score</th>
<th>T-Score</th>
<th>Z-Score</th>
<th>Machine Name</th>
<th>Scan Result</th>
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<tbody>
<tr>
<td>19/03/2009</td>
<td>Spine L1 - L4</td>
<td>0.722</td>
<td>-3.0</td>
<td>-0.4</td>
<td>Discovery</td>
<td>Osteoporosis</td>
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<td>19/03/2009</td>
<td>Left Femur Neck</td>
<td>0.565</td>
<td>-2.6</td>
<td>-0.4</td>
<td>Discovery</td>
<td>Osteoporosis</td>
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</table>

<table>
<thead>
<tr>
<th>Region</th>
<th>Exam Date</th>
<th>BMD (g/cm²)</th>
<th>T-Score</th>
<th>Z-Score</th>
<th>Classification</th>
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<tbody>
<tr>
<td>Total Forearm (Left)</td>
<td>31.12.2009</td>
<td>0.347</td>
<td>-4.2</td>
<td>-1.2</td>
<td>Osteoporotic</td>
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<td>1/3 Forearm (Left)</td>
<td>31.12.2009</td>
<td>0.458</td>
<td>-3.9</td>
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<td>UD Forearm (Left)</td>
<td>31.12.2009</td>
<td>0.215</td>
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<td>-1.6</td>
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<td>Total Forearm (Right)</td>
<td>31.12.2009</td>
<td>0.341</td>
<td>-4.4</td>
<td>-1.3</td>
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<td>1/3 Forearm (Right)</td>
<td>31.12.2009</td>
<td>0.471</td>
<td>-3.7</td>
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<td>UD Forearm (Right)</td>
<td>31.12.2009</td>
<td>0.190</td>
<td>-4.3</td>
<td>-2.1</td>
<td>Osteoporotic</td>
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</tbody>
</table>

World Health Organization criteria for BMD interpretation classify patients as Normal (T-score at or above −1.0), Osteopenic (T-score between −1.0 and −2.5), or Osteoporotic (T-score at or below −2.5).
Intracortical and endocortical bone resorption in PHPT
Longstanding Hyperparathyroidism. Cortical thinning occurs everywhere including trabecular rich areas of bone such as vertebrae.