Skeletal Effects of Cerebral Palsy

Raja Padidela
Consultant Paediatric Endocrinologist & Senior Lecturer in Child Health
Royal Manchester Children’s Hospital
Overview

- Fractures in children with Cerebral Palsy (CP)
- Factors associated with fractures
- Dietary Calcium & Vitamin D
- Pharmacological Rx to improve low bone mass
- Non-pharmacological Rx to improve low bone mass
- Management of puberty and menstruation in CP
Cerebral Palsy

- A non-progressive disorder of posture & movement caused by an insult to the developing brain
- Incidence of 2-3 per 1000 live births
- ~ 150,000 children in the USA
- Wide spectrum of mobility & cognitive impairment
- ~ 20% have severe mobility & cognitive impairment
Skeletal complications of CP

- CP may determine a number of painful skeletal complications
  - Scoliosis
  - Joint subluxation and dislocation
  - Torsional bone deformities and
  - Fractures.
Fractures in CP Children

- Prevalence of # \((Henderson\ et\ al.\ Pediatrics\ 2002;\ 110:1-10)\):
  - GMFCS 3, 4 & 5 (limited or no ambulation)
  - 179 children
  - Mean age 9.7 years (2 to 18 years)
  - 26% >10 yr olds sustained #s

- Systematic review \((Mergler\ et\ al.\ DMCN;\ Vol\ 51,\ 2009)\):
  - Prevalence of fracture 12-23% mainly of long bone
  - Incidence of 2.7-4.5%

- Causes of #s:
  - Routine care, moving & handling
  - Physiotherapy
  - Muscle spasms/seizures
  - Trivial falls
Epidemiology of fractures in CP Swedish cohort

- 536 CP born between 1990-2005
- 384 children- GMFC 1 to 3- risk of # similar to normal developing child
- 152 children- GMFC 4 to 5- risk of # higher compared to normal developing child

Fractures in children with cerebral palsy: a total population study
Wort et al. DMCN Volume: 55 Issue: 9; SEP 2013
Two fold increase in fractures in GMFCS levels IV-V on AED therapy (p=0.004).

The risk for fractures without trauma in children with stunted growth (height for age <-3 SD) and those who did not use standing devices was significantly increased.

Fractures in children with cerebral palsy: a total population study
Wort et al. *DMCN* Volume: 55 Issue: 9; SEP 2013
Fractures in Cerebral Palsy
Fractures in Cerebral Palsy
Impact of Fractures

- Pain & ↑disability
- Hospitalisation & missed schooling
- Loss of mobility
- Non-accidental Injury (Child abuse)
- Litigation
Impact of Fractures

- Shortening or mal-union at the fracture site because of spastic muscle tone
- Recurrence of fractures at the same site
Factors associated with fracture risk
Factors associated with increased # risk

- Previous fracture: *recurrent #s at the same site*
- Post surgery immobilisation: *Spinal/Hip Spica*
- Feeding & swallowing problems, GOR
- Anticonvulsants
- Low BMD & ‘slender bones’
Assessing bone health in CP

- Plain radiographs- Subjective assessment
  - “washed-out appearance,”
  - thinning of the cortices, and possible fractures.
  - These changes usually are not detectable on a radiograph until approximately 30% of bone mass is lost.

- In contrast, dual-energy x-ray absorptiometry (DXA) can detect bone mineral loss of 2% to 5%.
Assessing bone health in CP

- DXA scan is influenced by size and hence normative reference value of children is required
- Quantitative CT (Q-CT) scan measures volumetric bone density - less effected by size
- RMCH has facility of measuring bone density using DXA and Q-CT with locally available reference data
Calcaneal BUA & Vertebral vTBMD in children with CP


N= 27; 5 - 14 yrs
Calcium & Vitamin D
Pharmacological Rx (Bisphosphonates)
Bisphosphonate Rx in CP

- IV Pamidronate 3-4 monthly in 25 children with severe quadriplegic CP with at least 1 non-traumatic fracture
- Fracture rate decreased from 30.6%/yr before treatment to 13%/yr after treatment
  
  Bachrach et al Dev Med Child Neuro ; Sept 2010

- 23 non-ambulant CP children
- I.V Pamidronate (1.5 mg/kg 4 monthly) for 1 year
- Significant improvement in LS (-3.8 to -2.3) and FN (-4.5 to -2.6) aBMD
  
  Plotkin et al, Dev Med Child Neuro 2006; 48: 709-712

- RCT: 6 pairs of CP children with quadriplegic CP
- Randomised to IV Pamidronate (3 mg/kg 3 monthly) or saline, 3 monthly for 1 year
- BMD in distal femur ↑ by 89% in intervention group compared to 9% in controls
  
  Henderson et al, J Paeds 2002; 141: 644-651
Pamidronate effect on LDF R1 during and after Stopping Treatment

Potential implications of stopping Rx in a Growing Child

Ward, Adams, Freemont, Mughal. Osteoporosis International. 2007; [Epub ahead of print]
Non-pharmacological Rx
Proximal Tibial vTBMD

Active: +6.3% increase; Placebo: -11.9% decrease

Spine (L2) (p=0.43)

Active + 7.29 mg/ml (6.5%)
Placebo + 0.56 mg/ml (0.3%)

Mid Cortical Tibial Parameters (all non significant)

- Whole bone area (mm$^2$)
- Whole bone circumference (mm)
- Whole bone density (mg/mm$^3$)
- Cortical area (mm$^2$)
- Cortical thickness (mm)
- Polar moment of inertia (mg/mm)

BonAlyse 1.3, Jyväskylä, Finland

The Cologne Standing-&-Walking trainer powered by the ‘Galileo vibrating platform’

Issues of Bone Health in Children with Chronic Neuromuscular Disorders

- Where possible maintain mobility
- Avoid prolonged immobilisation after fracture/surgery
- Avoid vitamin D deficiency
- Mineral intake tailored to the mobility status?
- Bisphosphonates Rx regimens in non-ambulatory CP children?
- Bisphosphonates prior to surgery requiring prolonged immobilisation?
Informing evidence-based clinical practice guidelines for children with cerebral palsy at risk of osteoporosis: a systematic review

Developmental Medicine & Child Neurology
Vol 54; Isu 2; pages 106-116, 24 NOV 2011 DOI: 10.1111/j.1469-8749.2011.04091.x
Informing evidence-based clinical practice guidelines for children with cerebral palsy at risk of osteoporosis: a systematic review

Child/adolescent with osteoporosis (fragility fracture[s])
consider additional investigations

Lab tests
- Calcium
- Phosphate
- PTH
- Alkaline phosphatase
- 25-OH-D
- Creatinine
- Ca/Osmolality ratio (spot urine)

X-rays
- X-ray of ‘Symptomatic Area’ to assess for possible fracture
- Consider need for lateral spine x-ray to assess for the presence of vertebral compression fractures
- X-ray of wrist for bone age or rachitic changes

DXA scans
- Use DXA z-scores adjusted for child’s age, sex, and height

Refer for consultation to a bone health specialist:

Step 1: Ensure adequate Vitamin D and Calcium

Step 2: Consider bisphosphonates (use with caution)

Colour legend for treatment effectiveness on BMD (evidence):
- Green: Effective (A)
- Yellow: Probably effective (B)
- Orange: Possibly effective (C)
- Red: Data inadequate (U)
Summary points

- Osteoporosis (low BMD) is common in children with cerebral palsy
- Decreased BMD is associated with increased fracture risk
- Risk factors for low BMD in CP include immobility, malnutrition (especially calcium and vitamin D deficiency) and use of anti-convulsants
Summary points

- Standing, vibration and adequate intake of calcium and vitamin D
- Children with history of significant fractures are candidates for bone density scanning and pharmacologic treatment.
- Bisphosphonates are the drug of choice in such cases.
Summary points

- Optimal duration of therapy is not known but may be 2–4 years.
- Adverse effects should be discussed and appropriate precautions taken.
CP: Menstrual Problems and bone health

- Risk of central precocious puberty (CPP) is high
- CPP should be treated with GnRH analogues
- Timely withdrawal is required for bone mass accrual
CP: Menstrual management and/or suppression

- Opportunities to improve quality of life by
  - Achieving amenorrhea
  - Relieving pain and menstrual-related symptoms, and
  - Providing contraception

- This in turn improves
  - Hygiene
  - Mitigates restrictions on activities and absenteeism from school
  - Elevates privacy and modesty, and
  - Decreases caregiver burden
Complete suppression of menstruation will lead to decrease in bone mineral density/bone strength
Trends in the management of menstruation in CP

Figure 1. Caregiver and patient concerns.
# Trends in the management of menstruation in CP

## Table 3
Initial selection for menstrual suppression

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<tbody>
<tr>
<td>Postmenarchal patients</td>
<td>n = 41</td>
<td>n = 215</td>
<td></td>
</tr>
<tr>
<td>DMPA</td>
<td>24 (58.5)</td>
<td>25 (11.6)</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>OCP (extended or continuous regimen)</td>
<td>7 (17.1)</td>
<td>91 (42.3)</td>
<td>.003</td>
</tr>
<tr>
<td>Expectant</td>
<td>3 (7.3)</td>
<td>32 (14.9)</td>
<td>.319</td>
</tr>
<tr>
<td>Patch</td>
<td>43 (20)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LNG-IUS</td>
<td>6 (2.8)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

DMPA = depot medroxyprogesterone acetate; LNG-IUS = levonorgestrel intrauterine system; OCP = oral contraceptive pill.

<sup>a</sup> Age, heavy menses, ADL dependence, wheelchair use, feeding tube, or seizures did not predict selected initial method (p > .01).
Thank you

Questions?