One too many fractures: A case of severe bone demineralization following anoxic brain injury

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Introduction

Limited knowledge exists on osteopenia development after pediatric anoxic brain injury. This case details the ultra-rapid onset of low bone mineral density (BMD) in an infant following near-drowning, presenting comprehensive longitudinal data from injury to recovery.

Case

- An otherwise healthy girl sustained a near-drowning event leading to cardiac arrest and anoxic brain injury at 12 months of age.
- Complications included spastic quadriplegia, chronic pain, seizures, neurostorming and catheter-related thrombosis.
- At 15 mo of age, extensive demineralization and healing fractures of humeri, ulnas, right femur, talus, and calcaneus, and left first metatarsal were found during evaluation for increased pain post physical therapy.

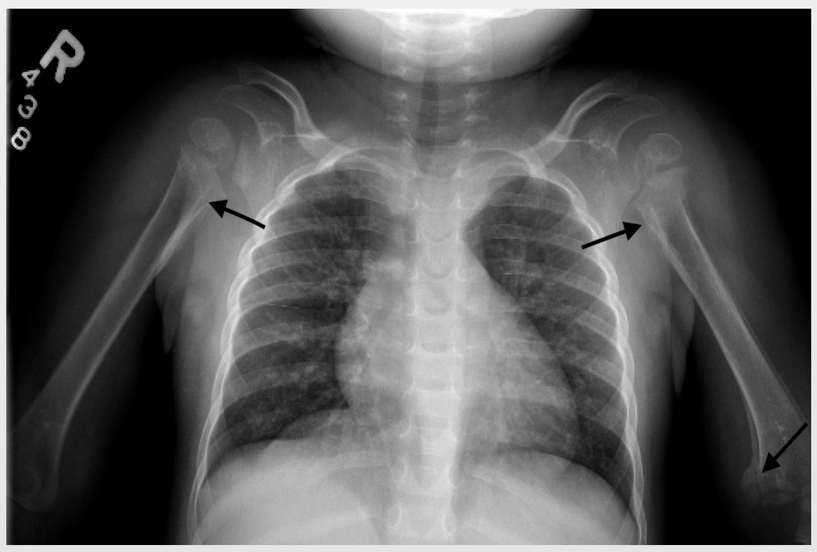

Image 1: Arrows indicate position of fractures, callus formation. Also noted - diffuse osteopenia.

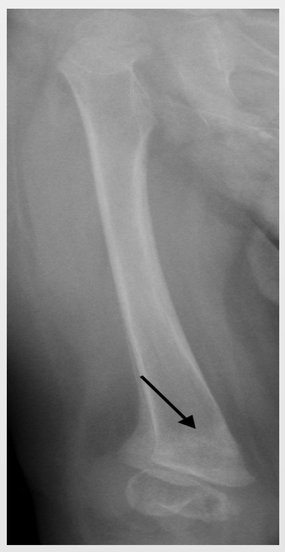

Image 2: Arrows indicate position of fractures and callus formation

- Non-accidental trauma was ruled out.
- Endocrine workup showed normal serum minerals, calcifediol, calcitriol, osteocalcin, thyroid stimulating hormone (TSH) and free thyroxine levels. Parathyroid hormone (PTH) was also within normal range, with elevated C-telopeptide and alkaline phosphatase levels (ALP), suggesting increased bone turnover.

Component	Value	Reference Range
Alkaline Phosphatase	370	129 - 291 U/L
Calcium	9.6	8.7 - 9.8 MG/DL
Phosphorus	6.7	3.5-6.8 MG/DL
Magnesium	2.0	1.6-2.6 MG/DL
IGF1	283	15 - 175 ng/mL
IGF Binding Protein	3.4	0.7 - 3.6 mg/L
Vit D 25 OH	36.5	16.2-63.0 NG/ML
VIT D 1, 25 Dihydroxy	38	31 - 87 PG/ML
Parathyroid Hormone	19.6	16.2 - 63.0 PG/ML
C-Telopeptide	2023	600-2000 PG/ML
Osteocalcin	84	44 - 130 ng/mL
Thyroid Stimulating Hormone	2.7	0.700 - 4.100 uIU/ML
Free Thyroxine	2.0	0.8 - 2.0 NG/DL

Table 1: Laboratory values at 15 months of age

- Genetic testing was negative for osteogenesis imperfecta.
- Ergocalciferol 800 IU and 25 mg/kg/day elemental calcium was supplemented, in addition to full gastric tube formula feeds.
- At 19 mo of life ALP continued to range from normal to mildly elevated; c-telopeptide and PTH levels were normal. Repeat imaging showed worsening osteopenia until 6 months post-event, followed by stabilization.
- Child was discharged at 20 mo of age without new fractures.

Component	Value	Reference Range
Alkaline Phosphatase	322	129 - 291 U/L
Calcium	9.6	8.7 - 9.8 MG/DL
Phosphorus	6.5	3.5-6.8 MG/DL
Magnesium	1.9	1.6-2.6 MG/DL
Vit D 25 OH	34.0	16.2-63.0 NG/ML
Parathyroid Hormone	23.7	16.2 - 63.0 PG/ML
C-Telopeptide	1309	600-2000 PG/ML
Osteocalcin	92	44 - 130 ng/mL

Table 2: Laboratory values at 19 months of age

Discussion

- Immobility results in reduced biomechanical bone loading, which leads to decreased osteoblastic activity and increased osteoclastic activity.[1]
- Traumatic brain injury leads to increased permeability of the blood brain barrier to blood products, tissue debris, reactive oxygen and nitrogen species, which activates activates a systemic inflammatory response stimulating osteoclast activity and skeletal deterioration.[2]
- Disruption of hypothalamic-pituitary axis from brain injury leads to increased ACTH, prolactin and growth hormone secretion, but decreased or unchanged gonadotropin, melanocyte-stimulating hormone, and TSH levels. The altered secretion of hormones impairs osteoblast function and bone formation.[2]
- No pediatric data is available that demonstrates timeline from brain injury to development of osteopenia or osteoporosis. Adult stroke studies suggest that demineralization occurs between 0.8-8.2 months, peaking at 4 months post-injury, which is similar to our case.[3]
- Pediatric data on anoxic brain injury - related osteopenia and use of bisphosphonates versus supplemental vitamin D and calcium is again limited. However adult studies have shown that combined use of Vitamin D and calcium supplementation leads to improvement in BMD and decreased bone turnover markers.[4]
- In our case, BMD stabilization was attributed to the natural post-injury healing timeline along with vitamin D and calcium supplementation.

Conclusions

- Ultra rapid decline in BMD can be seen after anoxic brain injury in infants and toddlers, and is possibly underestimated.
- Basic labs such as calcium, phosphorus, calcifediol and alkaline phosphatase can be normal in such patients.
- Early supplementation with calcium and vitamin D aids in BMD stabilization, bone healing and could help with fracture prevention.
- Further studies are needed for the development of screening, monitoring, and treatment guidelines in this population.

Acknowledgements/Literature Cited

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