IATROGENIC ORTHOPAEDIC INJURIES IN CHILDHOOD

NEIL PRICE
St George’s Hospital
<table>
<thead>
<tr>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Iatrogenic</strong> = <em>iatros</em> Gr. Physician</td>
</tr>
<tr>
<td>= <em>gennan</em> Gr. to produce</td>
</tr>
</tbody>
</table>

"Any effect, usually adverse, resulting from the activity of a physician or surgeon "

*Dorland's Medical Dictionary 20th Ed.*
IATROGENIC ORTHOPAEDIC INJURIES IN CHILDHOOD

ORTHOPAEDIC INJURIES

• Fracture Treatment
• Paediatric orthopaedic treatment
• Radiotherapy

NON-ORTHOPAEDIC INJURIES
Plaster casts

- Sores
- Compartment syndrome
- Burns
- Cast syndrome
Plaster casts - burns

- Exothermic reaction on setting
- Reports of partial & full thickness burns
- Burn if 50°C for 5-15min
- Heat sink

Precautions
- Thinnest possible that will do job
- Wet thoroughly with tepid water
- Do not wring dry
- Do not wrap with bandage until dry
Plaster casts - cast syndrome

- Persistent vomiting in patients treated in hyperextension body jackets post fracture or operation
- Due to obstruction of third part of duodenum by superior mesenteric vessels
- Split /remove cast
- Avoid excessive extension

Skin Traction

- Skin resists compression better than shear
- Avulsion of superficial layers if >8lbs applied for any length of time

Tourniquet effect of bandages
Bryant’s (Gallows) Traction for femoral fracture

- Bryant 19th century advised:
- Against use in children older than 3 years of age
- Use of splint on legs to prevent knee hyperextension

Volkman’s contracture reported 1950
Gallows Traction - Volkman’s ischaemia
Nicholson et al JAMA 1955

Causative factors

• Reduction in hydrostatic pressure in lower limbs when held overhead proportional to length of limb
• Excessive traction (proportional to weight)
• Tight bandaging
• Shock
• Hyperextension of knee
• Ischaemia from compartment syndrome or vascular injury
Gallows Traction & Volkman’s ischaemia Prognosis - Mubarak & Carroll
JBJS 61B 1979

- 9 children (10 limbs)
- 2 cases on non-fractured side!

Retrospective review showed:
- all diagnosed late
- head injury delayed recognition
- Poor long term functional result once established
Prevention

• Should **not** be used for child >2yrs
  >30lbs

• Care wrapping leg

• Avoid knee hyperextension

• Frequent neurovascular checks
Skeletal Traction pin

- Growth plate damage by heat if power drilled
- Tibial pin ≥ 2 finger breadths distal to tibial tuberosity
- Deep peroneal nerve at risk
- Angle over muscle onto tibia avoiding penetration of muscle (Nicol)
Skeletal Traction pin

- Recommended method of insertion angling over muscle & neurovascular bundle
Supracondylar Fractures - closed pinning

Royce et al JPO 11: 191-4 1991

• Ulnar nerve injury in 4/143 due to use of medial pin

Two types of palsy:
• **Immediate** due to direct damage by pin
• **Delayed** due to nerve contusion, oedema or stretch of nerve over pin
Supracondylar Fractures - closed pinning

- Recommend medial **incision** and placing drill guide onto bone
- Replace pins showing malposition on II
- Direct damage should be treated by exploration to remove pin from nerve
- All four palsies recovered after 6 months
Proximal Tibial Osteotomy

- Apophyseal or growth plate damage therefore more distal
- Iatrogenic fractures
- Compartment syndrome
- Peroneal palsy
- Vascular injuries

Neurovascular complication rate 3.3 - 18%
Proximal Tibial Osteotomy

Aetiology of peroneal palsy

- Anterior tibial A. compromise (Steele 1971)
- Anterior compartment syndrome
- Traction injury during exposure or correction
Proximal Tibial Osteotomy

Technical recommendations

• Meticulous haemostasis
• Prophylactic fasciotomy
• Non-constrictive splints/bandages
• *Distal* fibular resection

Slawaski et al JPO 1994 4.3% (255)
Peroneal Palsy - *Slawaski et al JPO 1994*

**Predisposing factors:**
- Older children
- Increased blood loss & tourniquet time
- Difficulty in exposure
- Angulatory > rotational

- Recovery in all cases between 3 days and six months (two required exploration)
AVN post treatment of DDH

- Classification & natural history of iatrogenic AVN
- Pavlik Harness
- Closed reduction & splintage
- Open reduction
Severity & Prognosis of AVN

- Kalamchi & MacEwen  JBJS 62A  1980
- 119 patients with AVN post treatment
- F/U 0.5-27  (Av 9) years
- 8/79  (~ 10%) unilateral cases developed AVN in the normal hip
- **Physeal** involvement  rather than of ossific nucleus dictated outcome
- Classification system
Severity & Prognosis of AVN - Group I

Changes affecting the ossific nucleus

- Delay in appearance of ossific nucleus
- Mottling
- Flattening & fragmentation
- Head spherical no changes in neck
Severity & Prognosis of AVN - Group II

Lateral physeal damage

Head changes like Gp I but in addition:

- Lateral ossification
- Physeal irregularity & bridging
- Lateral epiphyseal notching
- Lateral metaphyseal defect
Group II - late effects

- Age 9-10 develop valgus neck deformity
- Directs most of articular surface out of acetabulum
- Overgrowth of greater trochanter
- Early OA
Severity & Prognosis of AVN - Group III

Central Physeal Damage

- Central metaphyseal defect
- Central bridging
- Eventually short neck without alteration of neck-shaft angle (leg length discrepancy)
- GT overgrowth (GT epiphyseodesis)
Severity & Prognosis of AVN - Group IV

Total damage to head & physis

- Early femoral head irregularity
- Coxa magna
- Irregular, wide, short neck with medial beak
- Varus neck
- Acetabular dysplasia
Outcome after iatrogenic AVN

Cooperman et al. JBJS 1980

• 25 patients @ 39 year follow up
• Av age 42yr
• in 96% radiographic signs of OA
• 80% disabling symptoms

Iatrogenic AVN very grave prognosis
Iatrogenic Problems with Pavlik Harness

- Excessive flexion
  - obturator dislocation
  - femoral nerve neuropraxia

- Excessive abduction
  - AVN

- Brachial plexus palsy
AVN with Pavlik Harness

- Incidence higher when treating Dislocation as compared to subluxation
  - Pavlik 2.8%
  - Tonnis 15%
  - Kalamchi 0%
- Excessive abduction causes pressure on posterior vessels against posterior lip of acetabulum
- Human rather than frog position
Closed reduction & splintage

Higher incidence of AVN associated with:

• Older age
• Reductions performed without GA
• No pre-op traction?
• Eccentric reduction or persistent dislocation
• Splintage in excessive abduction
Open Reduction of DDH

- **Choice of approach**
  Most commonly used is the anterior approach (2 -15% AVN)
- Medial Ludloff approach in younger children
- Recent reported that late results show >50% satisfactory results at 19yr follow up
- Eccentric reduction & AVN of 43% (mostly Gp II)
  Koizumi et al  JBJS 78B  Nov 1996
SUFE - chondrolysis

- Necrosis of articular cartilage of hip (6%)
- *Unrecognised* pin penetration proposed as a cause (51%)
- Animal studies show changes worse the longer the duration of penetration
- Can also occur in untreated slips
- Immunological
- Genetic predisposition
Chondrolysis with SUFE

- No direct evidence to support the theory that transient pin penetration alone causes chondrolysis

- Zionts *JBJS (US) 1991* followed 14 cases of transient pin penetration for 3yr - no cases of chondrolysis

- However should be avoided if possible
Radiotherapy in childhood

- Effects noted by Perthes’ 1903
- As more children survived malignancy the magnitude of the effect was realised
- Most obvious effect is on growth
- Mediated by:
  - **Systemic** endocrine effect of hypothalamic irradiation
  - **Local** effect on growth plate & bones
Radiotherapy - pathological effects

Effects seen in all components of growing bone:

- **Physis**: arrested chondrogenesis, decreased chondrocytes
- **Metaphysis**: deficient resorption of calcified bone & cartilage
- **Diaphysis**: altered periosteal activity
Radiotherapy - pathological effects

Late effects

- Small & medium vessel damage
- Reduced healing capacity
- Reduced blood supply to unirradiated bone less possibility for compensatory growth
- Reduction in bone strength - increased propensity to fracture
Radiotherapy - pathological effects

- Growth Plate
  - End result is suspension or retardation of chondrogenesis & osteogenesis with premature closure of growth plates
  
- Termination or suspension of bone growth
Clinical effects

- Axial shortening of long bones - limb length discrepancy
- Hypoplasia of flat bones
- Scoliosis (bony wedging & soft tissue “bowstring”)
- Joint degeneration
Factors

- Patient age: effect worse at times of growth spurt (<6yr or during adolescence)
- Radiation dose: >2000cGy dose dependant thereafter
- Radiation energy: newer megavoltage therapy absorbed less by bone
Radiotherapy - prognosis

- Growth effects months or years after irradiation
- Growth may resume if low dose therapy
- Muscle atrophy associated with underdeveloped bone eg sarcoma
Prevention

- Megavoltage linear accelerators
- Modified dose regimes
- Other modalities of treatment eg Ewings
- Hyperbaric oxygen
- Growth factors
Non Orthopaedic injuries

- UAC leading to vascular occlusion
- Extravasation injuries
- Fibrous bands in deltoid & quadriceps
- Post LP intradural dermoids
- Osteomyelitis from puncture
- Intraosseous infusion needles
- Birth injuries
UAC leading to vascular thrombosis
Farrar et al. JBJS 78B Oct 1996

Usually severely ill neonates - hypercoagulable
Birth asphyxia, Rhesus Disease, sepsis &
maternal diabetes can initiate intravascular coagulation

Umbilical artery catheters can also precipitate vascular disturbance

Blanching in 32% during infusion - stop infusion
UAC leading to vascular thrombosis
Stringel et al 1985

• 100 neonates with UAC's

• 32% developed blanching of lower limbs during infusions

• 2 cases of frank gangrene
UAC leading to ischaemia

- Primary treatment is heparin infusion + thrombectomy
- Surgery alone ineffective
- Conservative management for established gangrene
Lessons

• High index of suspicion on the part of NICU staff

• Early manipulation of coagulation system + surgical thrombectomy

• With established gangrene avoid the temptation to perform early surgery. Wait until demarcation well established as usually more distal than first expected
Extravasation injuries

- Result of intravenous cannula being or becoming misplaced with escape of irritant fluid into the subcutaneous tissues

- **Vesicants** - subcutaneous inflammation + necrosis with skin loss and ulceration - Calcium solns, cytotoxics, radiographic contrast agents

- **Irritants** - inflammatory reactions but rarely lead to necrosis - albumin, blood products, MTX

- **Innocuous** - absorbed without apparent damage
Extravasation injuries

- Compartment syndrome

1 case of Volkman’s contracture due to intravenous into leg

Mubarak & Carroll  *JBJS*  61B  1979
Extravasation injuries - management

Loth & Eversman  *Clin Orth*  272  1991

- Volume
- Host factors
- Type of agent
- Necrosis interval - time between escape & irreversible tissue damage
- Conservative treatment - compressive dressings, elev, observation
Extravasation injuries - management

- Patients seen after the necrosis interval are best treated non-operatively

- Surgery - decompression, drainage irrigation, therapeutic liposuction

- Rehabilitation
- Reconstruction
Fibrous bands in deltoid & quadriceps

- Due to multiple intramuscular injections especially tetracycline
- Post injection fibrosis in deltoid, quadriceps & gluteal muscles
- In deltoid fibrosis abduction contracture described where child unable to approximate forearms
- Patellar subluxation described in lateral quadriceps band
Post LP intraspinal epidermoid tumours

- Intraspinal epidermoid tumours are rare
- 41% are iatrogenic in origin following LP, injections, etc.
- Due to implantation of skin fragments within spinal canal
- Intradural, extramedullary
- Present with longstanding progressive LBP, radicular pain, hamstring spasm, gait abnormalities
Post LP intraspinal epidermoid tumours

- Investigation of choice MRI enhanced with Gd-DTPA
- Non operative treatment brought almost no relief
- Good prognosis if removed

Birth Injuries

- Less common nowadays with advances in obstetric practice
  - especially LSCS for delivery of breech presentation
  - better assessment of fetal maturity

- Most commonly clavicular fracture or mild brachial plexus palsy
Birth Injuries - incidence

Incidence has fallen steadily

1930’s  20 / 1000
1950’s  7 / 1000
1990’s  2-3 / 1000

Clavicle > Brachial plexus > Humerus & femur
Birth Injuries - aetiology

Risk factors

Birth wt > 4.5kg (maternal diabetes)
Wickstrom et al 1988

Breech delivery
Birth Injuries - aetiology

- Cervical spinal cord injury due to excessive traction to deliver arrested shoulder or forceful rotation of head from O-P to anterior

- Femoral fractures from groin traction in extended breech

- Humeral fractures shoulder dystocia in breech
Birth Injuries - clavicular fractures

- Most common
- Account for 40-50% of all birth injuries
- Usually greenstick mid third fracture (may be complete, oblique or transverse)
- Risk factors large birth weight and shoulder dystocia but most follow vertex deliveries.
Birth Injuries - clavicular fractures

- Present with “pseudoparalysis” and pain on handling
- May not be apparent if greenstick until callus palpable
- 5% of neonates with clavicular fracture will have brachial plexus palsy

Oppenheim et al 1990
Differential diagnosis

- Upper humeral osteomyelitis
- Separation of proximal humeral epiphysis
- Congenital pseudarthrosis of clavicle
  - if unilateral on opposite side to the heart
  - no callus or tenderness
  - smooth bone ends on X-ray
Clavicular fractures - treatment

- Symptomatic
- Careful handling
- Sling if very displaced
Proximal humeral epiphyseal separation

- Physis is a weak point which fails before ligaments and joint capsule
- Shoulder dislocations are rare
- Most apparent Shoulder dislocations are epiphyseal separations
- Any doubt resolved by U/S or arthrography
- Treat by immobilisation in IR for 2-3 weeks periosteal new bone by 6-10 days
Distal humerus & elbow

- Dislocation extremely uncommon
- X-ray’s suggest posteromedial dislocation but proximal radius & ulna too close to distal humerus

- Treatment realignment and splintage in posterior slab
- Prognosis - full or virtually full recovery in most cases
<table>
<thead>
<tr>
<th>Condition</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Humerus</td>
<td>Usually mid third, transverse complete. 2-3 weeks immobilisation across chest.</td>
</tr>
<tr>
<td>Femur</td>
<td>Bryant’s traction ± spica. Angulation $\leq 40^\circ$ will correct.</td>
</tr>
</tbody>
</table>
Proximal femur

- Fracture separation of FCE
- Mild flexion & ER
- X-ray - ? DDH or proximal femoral deficiency
- Normal acetabulum (index <30°)
- U/S or arthrogram
- MUA + Spica or Bryants traction
- Possible late coxa vara or femoral retroversion
THANK YOU & GOOD LUCK!