Complex Paediatric Spine Cases

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Optimizing Safety in Paediatric Spine Deformity Surgery

- How to better understand anatomy
- How to reduce deformity?
- How to preserve cord function?
- How to minimise blood loss?
- How to achieve bone fusion?
Optimizing Safety in Paediatric Spine Deformity Surgery

- 12 yr. old boy
- NF1
- Episodic quadraparesis
- Severe occipital pain
- Gross cosmetic deformity
NF1 Characteristics

- Neurologically unstable
- Hypervascular tissue
- Poor bone healing
Understanding the Anatomy

Biomodelling

stereolithography

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What are the applications in Complex Spinal Surgery?

- Understanding the individual bony anatomy of complex spinal deformities and pathology

- Explaining pathology and planned treatments to patients and families as part of the process of informed consent
What are the applications in Complex Spinal Surgery?

- **Custom designing** implants, approaches, resection margins or osteotomies

- **Intraoperative reference** – use during surgery to provide stereotactic anatomical information, reducing reliance on 2-d images and the use of intraoperative radiography

- **‘Dry Run’ Surgery** – testing to see if ‘off the shelf’ implants will provide satisfactory fixation
Figure 4. The 3D printed Biomodel (sagittal, posterior & upper cervical close-up views) uniquely demonstrated that the anatomy of the C2 laminae were of a sufficient size to accept fixation posteriorly in addition to the previously planned fixation points in base of skull and upper thoracic spine.
Reducing the Deformity

Halo Traction

- OPD treatment
- Up to 50% body weight
- 3-6 months
Reducing the Deformity

Halo Traction

- Improves respiratory function
- Safely improves deformity
- Safely stabilises neurology
Intra Operative Neuro Monitoring

Problem:
Permanent loss of cord function 1/1000 in AIS

Why Monitor:
Allows immediate remedial action
Intra Operative Neuro Monitoring

Standard IONM:-

• **SSEP**
  - Monitors dorsal sensory columns
  - False (-) of primary motor deficits
  - Delayed registration of vascular insult

• **TcMEP**
  - Used in conjunction with SSEPs
  - Sensitive to anaesthetic agents
  - Sensitive to temperature
  - Sensitive to BP
Intra Operative Neuro Monitoring

Critical Change in monitoring:
- >65% loss of MEP Amplitude

Management algorithm:
- Check leads
- Elevation BP >80mm Hg
- Warm patient
- Correct last instrumentation manoeuvres
- Stop Surgery/remove implants
Ultimate objective is to reduce to a minimum the exposure to allogenic blood transfusion and to transfusion associated risks.
Transfusion associated risks

- ‘Clerical mistakes’ or ‘wrong blood’ administrations – (1/15 000–20 000)
- Blood borne infection
- Incompatible haemolytic reactions
- Graft-versus-host disease
- Metabolic disorders
- Transfusion-related acute lung injury
- Transfusion related immunomodulation
Local surgical strategies

- 2 Surgeons
- Patient positioning
- Skin Infiltration
- Subperiosteal dissection
Controlled Hypotensive Anaesthesia

- Mechanism remains unclear
  - Depends on both on local blood flow and vascular resistance
  - Blood loss influenced more by venous pressure rather than arterial pressure
- Has been shown to reduce blood loss in combination with haemodilution (1)
Local Pro-haemostatic Methods

- **Fibrin Sealants** Tissucol/Tisseel® (Baxter), Beriplast® (Behring), Hemaseel® (Hemacure) and CoStasis® (Cohesion Tech)
- Stimulates the formation of a fibrin clot – initiates final stage of clotting cascade
Systemic Pro-haemostatic Methods

- **Tranexamic Acid**
  - Synthetic lysine analogues prevents plasminogen- and/or plasmin-mediated fibrinolysis
  - Variable results
  - Reduces intraoperative bleeding in paediatric scoliosis correction as shown in randomised placebo-controlled study without added complications (14)
Systemic Pro-haemostatic Methods

• Tranexamic Acid
  – Decrease in intraoperative bleeding and need for transfusion in spinal fusions for Duchenne muscular dystrophy scoliosis
  – Thromboembolic events rarely reported; including post-operative MI, DVT, PE, cerebral thrombus, acute renal cortical necrosis and central retinal artery and vein obstruction (15)
Alternatives to allogenic blood transfusion

• Perioperative cell salvage
  – Indicated in procedures with anticipated postoperative blood loss between 750 and 1500 ml, allowing for the recovery of at least the equivalent to 1 unit of packed red blood cells

• No Coagulation factors replaced
• C/I with infection & some malignancies
Spinal Fusion

- Gold standard = autogenous bone graft

- Alternative substitutes / new biological strategies:
  - bone extenders
  - allografts
  - BMP
Biology of spinal fusion

1. Osteogenic potential
2. Osteoinductive factors
3. Osteoconductive scaffold
Biology of spinal fusion

1. Osteogenic potential
   = Transplanted osteoblasts and periosteal cells directly produce bone
   → Fresh autogenous bone and bone marrow cells
Biology of spinal fusion

2. Osteoinductive factors
   = Growth factors encourage mesenchymal stem cells (MSCs) to differentiate into osteoblastic lineages
   
   Bone Morphogenetic Proteins and bone marrow/periosteum
3. **Osteoconductive scaffold**

- Provides matrix for bone growth (infiltration of osteogenic cells into the graft)
- Cancellous autografts/allografts, DBM, hydroxyapatite, collagen, calcified phosphates.
Bone Morphogenetic Proteins

- TGF-β superfamily (20 proteins)
- Receptor stimulation
- Selective gene expression
- Induces proliferation and differentiation of MSCs into osteoprogenitor lineage
Bone Morphogenetic Proteins

- Expensive
- Large doses – osteoclastic initially
- Concern re. -inducing Neoplasia
What happened?
- Halo traction 6 months
- Tissue expanders
- Surgery
- Halo vest 6 months
- 12 hr. Operative time
- Entire blood volume loss
- Tibial graft/allograft
- Instrumented Occ. –T2
- No BMP
At 12 Months

- Pain resolved
- Neurol. “normal”
- ? Bone union
- Cosmetically improved
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THANK YOU