PAEDIATRIC PATIENTS IN THE PRONE POSITION

Dr Jan Cernovský
Positioning

Its aim is to offer maximum acceptable access to the operative field

Poor positioning can prolong and complicate the surgical procedure

Any posture that exceeds patients tolerance can inflict physiological or physical injury
Components of safe positioning

Planning
- what operation
- patient size and shape

Knowledge
- operating table
- principles
- physiology

Teamwork
- sufficient personnel
- team leader
# Components of safe positioning

<table>
<thead>
<tr>
<th>Planning</th>
<th>what operation patient size and shape</th>
</tr>
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<tbody>
<tr>
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<td>operating table principles physiology</td>
</tr>
<tr>
<td>Teamwork</td>
<td>sufficient personnel team leader</td>
</tr>
</tbody>
</table>
- Congenital
- Vertebral anomalies
• Congenital
• Vertebral anomalies
• Syndromic
  – Retts
• Congenital
• Vertebral anomalies
• Syndromic
  – Retts
  – Neurofibromatosis
• Congenital
• Vertebral anomalies
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  – Neurofibromatosis
  – Marfans
• **Congenital**
• **Vertebral anomalies**
• **Syndromic**
  – Retts
  – Neurofibromatosis
  – Marfans
  – Prader-Willi
- Congenital
- Vertebral anomalies
- Spina Bifida
- Syndromic
  - Retts
  - Neurofibromatosis
  - Marfans
  - Prader-Willi
  - Mucopolysaccharidoses
• **Neuromuscular**
• **Muscular dystrophies**
• **Duchenne Muscular dystrophy**
• **Spinal Muscular Atrophy**
• **Cerebral palsy**
• Idiopathic
Pre-anaesthetic evaluation

Starts with pre-op visit
  What operation and how long?
Previous complications?
Medication / steroids
Musculo-skeletal problems: Neck/Joints?
Voluntary range of movements
What position will the surgeon require?
Is the patients going to change the position during the procedure?
Write down you concerns on anaesthetic record sheet!!
Discussed

Signature
s/ date

Patient's details

Urine sample result

Blood availability

Airway assessment

Monitoring printouts

Date

Name
Prone positioning during anaesthesia is associated with well-documented complications, including the rare but potentially disastrous visual loss, with an incidence of up to 0.2%. \cite{1} When patients or parents give consent to spinal surgery, are they aware of the risks associated with intraoperative positioning?

In the UK, there is currently no standard consent process for prone positioning or national guidance on the required intraoperative safety measures and documentation.

A retrospective audit of 100 case notes of paediatric patients undergoing spinal surgery in the prone position between June and December 2013. We performed the audit in order to examine: 1) The consent process for prone positioning by the surgical and anaesthetic teams and 2) the Intraoperative documentation of safety measures undertaken.

The main reason for prone positioning intraoperatively was scoliosis correction

<table>
<thead>
<tr>
<th>Data collected</th>
<th>Range (n=100)</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surgery type</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Scoliosis correction/Surgical access for procedure</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>10-18yr</td>
<td>15</td>
</tr>
<tr>
<td>Duration of surgery</td>
<td>90-360 minutes</td>
<td>204</td>
</tr>
<tr>
<td>Surgical consent mentioning risk of prone position</td>
<td>-</td>
<td>0</td>
</tr>
<tr>
<td>Surgical consent mentioning risk of visual loss</td>
<td>-</td>
<td>14</td>
</tr>
</tbody>
</table>

ANAESTHETIC

DOCUMENTATION

Patient position documented 96

Patient position not documented 4
Surgical Consent

NOT Document Prone Risks

Risk of Blindness
Anaesthetic Discussion
Components of safe positioning

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Teamwork
- sufficient personnel
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Theatre preparation

Operating table:
- Different models for different procedures
- Manual or electric
- Familiarity with controls
- Weight limits
- Attachments e.g. supports, arm boards etc
- Metal edges and patient contact

Ask surgeon: ‘what position?’
Knee - chest position
Jackson table
Pro AXIS
ALLEGRO
Relton frame
Relton frame
Face protection
GEL SUPPORT
Principles

Beware when turning / personnel / timing
Dropping the patient - brakes on, no gaps
Loss of airway / lines / urine catheter etc
Keep table CLEAN / plastic parts / covers can be dangerous
Principles

Face protection
Acceptable arm positioning / Brachial plexus injury
Use the equipment properly - Montreal mattress / sheet
Breast and genital injuries
Eye abrasions, ear compression
Facio-mandibular injuries
Cervical spine injury
Abdominal excursions
Pad bony prominences
Thermal haemostasis
Components of safe positioning

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CARDIAC ISSUES

• Volume of blood ejected by heart per minute

  = cardiac output

  Heart rate x Stroke volume = CO
abdominal compression

reduction in venous return

CO
abdominal compression

Increase intra-abdominal pressure

reduction in venous return

Increase epidural bleeding

fall in cardiac index

blood loss = CO
Increase in intra-thoracic pressure

Reduction in arterial filling
Reduction in left ventricular compliance

CO
• Volume of blood ejected by heart per minute

\[
\begin{align*}
\text{Heart rate} \times \text{Stroke volume} &= \text{cardiac output} \\
CO &= \text{cardiac output}
\end{align*}
\]
Changes in cardiac index and blood pressure on positioning children prone for scoliosis surgery

- The mean cardiac index was 3.1 l/min/m² in the supine position.
- 2.5 l/min/m² in the prone position.
- A reduction of 0.5 l/min/m² = 18.5%.
- Due to a reduction in SVI.

Anaesthesia 2013, 68, 742-746Z. E. Brown, M. Gorges, E. Cooke
CARDIAC ISSUES

• Heart rate
• Blood pressure
• Stroke volume / Stroke Index
• Cardiac output / Cardiac index
• Haemodynamic instability
Is low CO important?

- Poor tissue perfusion
- Poor organ perfusion (liver, kidney, brain, heart)
- Decreased cardiovascular reserve
- Metabolic acidosis
- Further decreased cardiovascular function
- Cardiovascular Collapse
To complicate the matter more...

• Patients with chest deformities such as pectus excavatum
• Severe deformity patients
• Syndromic patients
• Patients with cardiac problems
• Patients on certain medication
To complicate the matter more...

- Surgical pressure during instrumentation
- Bleeding
And more......

Propofol infusion syndrome
• severe metabolic acidosis
• rhabdomyolysis
• cardiac failure
• renal failure in non-critically ill patients
A transesophageal echocardiography examination clarifies the cause of cardiovascular collapse during scoliosis surgery in a child

Un examen par échocardiographie transœsophagienne précise la cause d’une défaillance cardiovasculaire pendant une chirurgie de scoliose chez un enfant

Victor M. Neira, MD · Letizia Gardin, MD · Gail Ryan, MD · James Jarvis, MD · Debashis Roy, MD · William Splinter, MD

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Case Report

Profound Intraoperative Metabolic Acidosis and Hypotension in a Child Undergoing Multilevel Spinal Fusion

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Severe Hypotension and Hepatic Dysfunction in a Patient Undergoing Scoliosis Surgery in the Prone Position

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SUMMARY
Many patients with neuromuscular disorders develop progressive scoliosis and require corrective surgery. We present a patient with hereditary motor and sensory neuropathies who developed severe hypotension during corrective surgery for thoracolumbar scoliosis. The haemodynamic disturbance was probably secondary to thoracic hyperlordosis and the knee-chest position and was aggravated by surgical manipulation. This may be prevented by tailored preoperative evaluation of different patient prone position supports and frames in order to select that which causes least cardiovascular and respiratory disturbance. This patient also developed severely deranged liver function postoperatively and the possible aetiology is discussed.
VISUAL LOSS

Yang Shen, MA, MS
Melinda Drum, PhD
Steven Roth, MD

BACKGROUND: Perioperative visual loss (POVL) accompanying nonocular surgery is a rare and potentially devastating complication but its frequency in commonly performed inpatient surgery is not well defined. We used the Nationwide Inpatient Sample to estimate the rate of POVL in the United States among the eight most common nonocular surgeries.

METHODS: More than 5.6 million patients in the Nationwide Inpatient Sample who underwent principal procedures of knee arthroplasty, cholecystectomy, hip/femur surgical treatment, spinal fusion, appendectomy, colorectal resection, laminectomy without fusion, coronary artery bypass grafting, and cardiac valve procedures from 1996 to 2005 were included. Rates of POVL, defined as any discharge with an International Classification of Diseases, Ninth Revision, Clinical Modification code of ischemic optic neuropathy (ION), cortical blindness (CB), or retinal vascular occlusion (RVO), were estimated. Potential risk factors were assessed by univariate and multivariable analyses.

RESULTS: Cardiac and spinal fusion surgery had the highest rates of POVL. The national estimate in cardiac surgery was 8.64/10,000 and 3.09/10,000 in spinal fusion. By contrast, POVL after appendectomy was 0.12/10,000. Those undergoing
• 5.6 million patients
• Ischemic optic neuropathy
• Cortical blindness
• Retinal vascular occlusion
• Spinal surgery / fusion 3.09 / 10,000
• Cardiac surgery 8.6 / 10,000
• Appendectomy 0.12 / 10,000
• Patients younger than 18 years had the highest risk of visual loss due to Cortical blindness
• Unlikely stroke
• Embolic event (air/fat)
closed claims review of 93 cases

Prolonged direct compression
Retinal vascular occlusion
Ischaemic optic neuropathy
Procedure related factors
  massive blood loss
  massive transfusions
  prolonged operative time
  Hypertension
Patient related risk factors
  Diabetes
  Smoking
Intraocular Pressure in Pediatric Patients During Prone Surgery

Peter Szmuk, MD,*† Jeffrey W. Steiner, DO,*† Radu B. Pop, MS,*† Jing You, MS,†§
David R. Weakley, Jr., MD,|| Dale M. Swift, MD,¶ and Daniel I. Sessler, MD§#
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• 2013
• 30 patients
• Neurosurgery
• Prone position
• Normal IOP in children is 8 - 15 mmHg
• Importance of ocular perfusion pressure
• Mean BP minus intra-ocular pressure
• 63% patients had IOP exceeding 30 mmHg
• 13% patients had IOP exceeding 40 mmHg
• IOP increased by average of 2.2 mmHg per hour
not just vision

• other nerve structure protection also
Triceps brachii

Extensor-supinator group

Dors. antibrach. cutan. n.

Deep radial n.

Extensors

Supinator

Axillary n.

Sensory distribution

Area of isolated supply

Wrist drop in radial n. injury
So what caused the spinal curvature? The only plausible mechanism, in my view, is that this was the result of spinal cord compression of the SCIWORA type in the context of ligamentous laxity, cervical extension and transmitted pressure from the efforts of the surgeons. I will explain what I mean by these factors one at a time.

SCIWORA stands for Spinal Cord Injury WithOut Radiological Abnormality. It is most common in children who have skeletally immature cervical and thoracic spines. Damage the spinal cord within, there are usually signs of bony or disc displacement and ongoing cord compression on subsequent scans. In children, however, the ligaments of the neck may have sufficient elasticity to allow enough intersegmental displacement that cord injury occurs, yet with spontaneous reduction in the position of the vertebrae such that imaging shows Spinal Cord Injury WithOut Radiological Abnormality [of the bones].

As an almost 14 year old child at the time of her operation, is therefore likely to have had a reasonably ‘elastic’ spine, simply on the basis of her age.

The Prader-Willi syndrome often presents as floppiness in the newborn period. Even now at the age of 18 and despite having cervical tetraplegia [where you might expect a great deal of spasticity], is mainly floppy. Low muscle tone and ligamentous laxity are features of the condition. I enclose a paper entitled ‘clinical concerns for the orthopaedic surgeon’ which lists ‘ligamentous laxity’ as a feature [for example in the first paragraph of the first page, just below the abstract].
• Flow trons, DVT
• Tapes, allergies, skin damage
• Pressure marks- blisters-pain-infection
• Toes
• Folded ears
• ETT kinking
• Compartment syndrome
Going Prone?

Be safe
Be vigilant
Be ready
TOP TO TOE

1. Head fitted correctly in the face cushion:
2. Eye brow line visible
3. Eyes lightly taped and NOT padded
4. Face Cushion supporting cheek bone and clear of eyes
5. Chin not resting on face cushion
6. Airways tubing clear, in correct central position
7. Small cuff and temperature probe lines not trapped between face & face cushion
8. Neutral neck line and head not extended
9. Throat free and not resting on any supports
10. Chin not resting against the chest support
11. Chest supported
12. Female breasts correctly positioned and supported
13. Arms in the correct 90° position forward with no pressure on elbows or brachia, unless placed backwards
14. Elbows protected, with lower arms and hands supported
15. Abdomen free and decompression area adequate
16. Pelvic supports correctly positioned and inguinal nerve not trapped
17. Groin area free - Genitalia should be positioned between the legs
18. Knees cushioned
19. Legs flexed
20. Ankles and feet hanging free
Thank you