

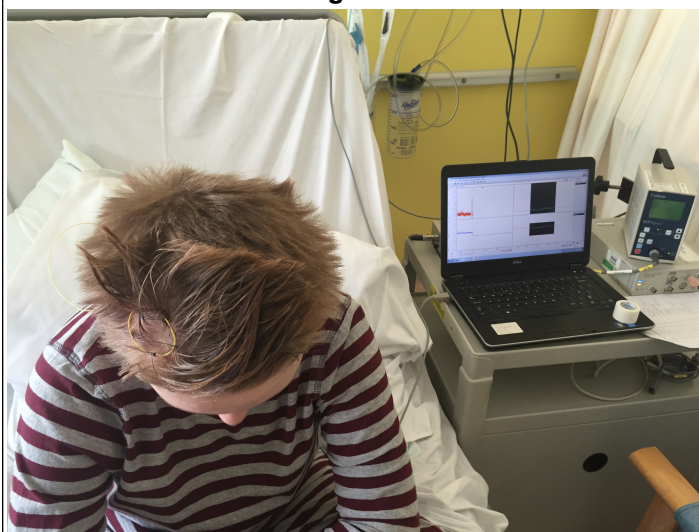
Introduction

Intracranial Pressure (ICP) monitoring is an important tool in the neurosurgeon's armamentarium. There are plenty of different ICP monitors available of which fibre-optic intraparenchymal devices are one of the most popular. Here we document our experience of ICP monitoring in the craniofacial department at the John Radcliffe hospital between 2005 and 2015.

Methods

A retrospective review was performed of the medical records of all paediatric craniofacial patients under going intracranial pressure monitoring at the John Radcliffe Hospital over the past 10 years. All patients had a intraparenchymal intracranial pressure monitor inserted under general anaesthetic. A twist-drill burr hole was placed at Kocher's point and a tunnelled ICP monitor was inserted, coiled and secured to the scalp. ICP recording was performed using Powerlab chart (ADI instruments). An average ICP over 15mm Hg or more than 3 B-type waves in 24-hour period during sleep was classified as raised. Statistical analysis was performed using the Minitab statistical software package (version 16; Minitab Inc.).

Figure 1



ICP monitor in situ connected to recording software

Table 1

| | |
|--|------------|
| Craniosynostosis | 227 |
| Hydrocephalus/ VP shunt dysfunction | 111 |
| Trauma | 20 |
| Benign intracranial hypertension | 8 |
| Intracranial Haemorrhage | 6 |
| Arachnoid cyst | 5 |
| Brain tumour | 4 |
| Other | 4 |

Indications for ICP Monitoring

Results

There were 385 separate operations with an overall complication rate of 8.3% (32/385). Indications for ICP monitoring can be seen in Figure 1. Hardware failure occurred in 4.2% of cases, CSF leak rate was 3.6%, postoperative haemorrhage was 0.5% and there was 1 infected case (0.3%). Our definitions of complications were very broad. Hardware failure encompassed any physical problem with the ICP probe from spontaneous failure to wire being snapped by patient tugging. CSF leak was defined by any leak of CSF through the surgical wound, or most commonly the tunneled exit site. This again, could be as small as a few drops of CSF after ICP probe removal, which resolved with simple pressure bandages to a continuous CSF leak that did not settle with a stitch and necessitated the early conclusion of ICP monitoring.

Figure 2

| | Total | Any complication | | | CSF leak | | | Hardware problem | | | Infection | | | Bleed | | | |
|------------------|-------|------------------|--------------------|---------|-----------|-------------------|---------|------------------|-------------------|---------|-----------|------------|---------|----------|------------|---------|--|
| | | N (%) | OR (95%CI) | P-value | N (%) | OR (95%CI) | P-value | N (%) | OR (95%CI) | P-value | N (%) | OR (95%CI) | P-value | N (%) | OR (95%CI) | P-value | |
| Syndromic | | | | | | | | | | | | | | | | | |
| No | 283 | 36 (12.7%) | 1.00 | | 9 (3.2%) | 1.00 | | 15 (5.3%) | 1.00 | | 1 (0.4%) | 1.00 | | 2 (0.7%) | 1.00 | | |
| Yes | 102 | 6 (5.9%) | 0.62 (0.25, 1.55) | 0.30 | 5 (4.9%) | 1.57 (0.51, 4.86) | 0.43 | 1 (1.0%) | 0.18 (0.02, 1.38) | 0.10 | 0 (0.0%) | | | 0 (0.0%) | | | |
| ICP result | | | | | | | | | | | | | | | | | |
| Normal | 277 | 18 (6.5%) | 1.00 | | 8 (2.9%) | 1.00 | | 8 (2.9%) | 1.00 | | 1 (0.4%) | 1.00 | | 2 (0.7%) | 1.00 | | |
| High | 108 | 13 (12.0%) | 2.14 (1.03, 4.48) | 0.04 | 6 (5.6%) | 1.98 (0.67, 5.84) | 0.22 | 8 (7.4%) | 2.69 (0.98, 7.36) | 0.05 | 0 (0.0%) | | | 0 (0.0%) | | | |
| Surgeon Grade | | | | | | | | | | | | | | | | | |
| Consultant | 29 | 1 (3.4%) | 1.00 | | 1 (3.4%) | 1.00 | | 0 (0.0%) | | | 0 (0.0%) | | | 0 (0.0%) | | | |
| Trainee | 356 | 31 (8.7%) | 2.67 (0.35, 20.30) | 0.34 | 13 (3.7%) | 1.06 (0.13, 8.43) | 0.96 | 16 (4.5%) | 1.48 (0.32, 6.81) | 0.65 | 1 (0.3%) | 1.00 | | 2 (0.6%) | 1.00 | | |
| Age at operation | | | | | | | | | | | | | | | | | |
| 0-5 | 13 | 0 (0.0%) | 1.00 | | 0 (0.0%) | 1.00 | | 0 (0.0%) | 1.00 | | 0 (0.0%) | 1.00 | | 0 (0.0%) | 1.00 | | |
| 6-10 | 158 | 12 (7.6%) | 1.00 | | 4 (2.5%) | 1.00 | | 8 (5.1%) | 1.00 | | 1 (0.6%) | 1.00 | | 0 (0.0%) | 1.00 | | |
| 11-15 | 208 | 20 (9.6%) | 1.18 (0.56, 2.48) | 0.67 | 10 (4.8%) | 1.77 (0.55, 5.76) | 0.34 | 8 (3.8%) | 0.68 (0.25, 1.87) | 0.46 | 0 (0.0%) | | | 2 (0.9%) | 1.00 | | |
| Overall | 385 | 32 (8.3%) | | | 14 (3.6%) | | | 16 (4.2%) | | | 1 (0.3%) | | | 2 (0.5%) | | | |

Analysis of complication rate as determined by various factors

Figure 3

| | Total | Any complication | | | CSF leak | | | Hardware problem | | | Infection | | | Bleed | | | |
|-------------------|-------|------------------|--------------------|---------|-----------|-------------------|---------|------------------|--------------------|---------|-----------|------------|---------|----------|------------|---------|--|
| | | N (%) | OR (95%CI) | P-value | N (%) | OR (95%CI) | P-value | N (%) | OR (95%CI) | P-value | N (%) | OR (95%CI) | P-value | N (%) | OR (95%CI) | P-value | |
| Prognosis | | | | | | | | | | | | | | | | | |
| Syndromic | | | | | | | | | | | | | | | | | |
| No | 125 | 14 (11.2%) | 1.00 | | 5 (4.0%) | 1.00 | | 7 (5.6%) | 1.00 | | 0 (0.0%) | 1.00 | | 2 (1.6%) | 1.00 | | |
| Yes | 102 | 6 (5.9%) | 0.50 (0.18, 1.34) | 0.17 | 5 (4.9%) | 1.24 (0.35, 4.40) | 0.74 | 1 (1.0%) | 0.17 (0.02, 1.38) | 0.10 | 0 (0.0%) | | | 0 (0.0%) | | | |
| ICP result | | | | | | | | | | | | | | | | | |
| Normal | 157 | 11 (6.9%) | 1.00 | | 6 (3.8%) | 1.00 | | 4 (2.4%) | 1.00 | | 1 (0.6%) | 1.00 | | 2 (1.2%) | 1.00 | | |
| High | 59 | 8 (13.6%) | 2.22 (0.85, 5.83) | 0.10 | 3 (5.1%) | 1.44 (0.35, 5.90) | 0.62 | 4 (6.8%) | 2.96 (0.72, 12.25) | 0.13 | 0 (0.0%) | | | 0 (0.0%) | | | |
| Surgeon Grade | | | | | | | | | | | | | | | | | |
| Consultant | 39 | 1 (2.6%) | 1.00 | | 1 (2.6%) | 1.00 | | 0 (0.0%) | | | 0 (0.0%) | | | 0 (0.0%) | | | |
| Registrar/ Fellow | 208 | 19 (9.1%) | 3.62 (0.52, 14.32) | 0.17 | 9 (4.3%) | 0.81 (0.18, 3.79) | 0.85 | 8 (3.8%) | 0.81 (0.18, 3.79) | 0.85 | 0 (0.0%) | | | 2 (0.9%) | 1.00 | | |
| Age at operation | | | | | | | | | | | | | | | | | |
| 0-5 | 13 | 0 (0.0%) | 1.00 | | 0 (0.0%) | 1.00 | | 0 (0.0%) | 1.00 | | 0 (0.0%) | 1.00 | | 0 (0.0%) | 1.00 | | |
| 6-10 | 158 | 12 (7.6%) | 1.00 | | 4 (2.5%) | 1.00 | | 8 (5.1%) | 1.00 | | 1 (0.6%) | 1.00 | | 0 (0.0%) | 1.00 | | |
| 11-15 | 208 | 20 (9.6%) | 1.18 (0.56, 2.48) | 0.67 | 10 (4.8%) | 1.77 (0.55, 5.76) | 0.34 | 8 (3.8%) | 0.68 (0.25, 1.87) | 0.46 | 0 (0.0%) | | | 2 (0.9%) | 1.00 | | |
| Overall | 385 | 32 (8.3%) | | | 14 (3.6%) | | | 16 (4.2%) | | | 1 (0.3%) | | | 2 (0.5%) | | | |

Subgroup analysis of complication rate in craniofacial patients

Figure 2 shows analysis of the results based on various factors. Only patients with hardware problems required further surgery as a result of their complication and no patients experienced any permanent morbidity or mortality. Younger patients ($p=0.001$) and patients with pathologically high ICP (13% c.f. 6.5%, $p=0.04$) were significantly more likely to suffer complications. There was no significant difference in complication rate between general neurosurgical patients and craniosynostosis patients (7.6% c.f. 8.8%, $p=0.67$, figure 3).

Conclusions

Intraparenchymal ICP monitoring is a safe procedure associated with low morbidity in the paediatric population. We suggest that it should be used with the reassurance of our safety profile, especially in the evaluation of patients with craniosynostosis.