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Methods and devices

A simple system of intracranial pressure monitoring for use by non-neurosurgeons

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Abstract. A technique is described for intracranial pressure monitoring that can be used in the intensive care unit by doctors with no neurosurgical experience. The system uses the extradural route, thus reducing the risks of intracranial haemorrhage and infection associated with techniques requiring opening of the dura and cannulating the brain.

Key words: Intracranial pressure – Extradural pressure monitoring – Head injury

Intracranial pressure monitoring was first used practically over 30 years ago and its value is well established. Despite this, however, it is rarely used outside a neurosurgical unit. As many patients in general intensive care units have deranged intracranial mechanics and have physical signs of raised intracranial pressure obscured by pharmacology a simple reliable method of measuring intracranial pressure would be of value. Such a system is described here.

Theoretical background

Intracranial pressure may be measured intraventricularly, intradurally or extradurally [7]. The first two methods require opening the dura which exposes the patient to infective risks. Extradural pressure is usually measured by placing a coplaner transducer on the dural surface several centimetres distant to a burr-hole [2]. The simple system is based on the transmission of intracranial pressure to a saline column fitted firmly into a small drill hole without penetrating the dura. The saline column is connected to an extradural transducer, pressure being displayed on an oscilloscope and chart recorder. This is achieved by drilling a hole with an 8-mm guarded drill into which is plugged firmly a three-way stopcock (Fig. 1).

Method

Insertion may be carried out at the bedside or in theatre, according to personal preference. The ideal choice of insertion site is the non-dominant frontal region, although in the presence of injury at this site the dominant hemisphere may be chosen. An insertion point just anterior to the coronal suture, which is normally palpable, in the line of the pupil is ideal. Hair is shaved for 5 cm around this point and the skin cleaned with Betadine or Chlorhexidine. Towels are draped over the head by the gowned and gloved operator exposing only the insertion site.

A 1-cm linear incision in the line of the pupil is made down to bone. Scalp bleeding is controlled by digital pressure each side of the wound until a small self retaining retractor is inserted and the wound

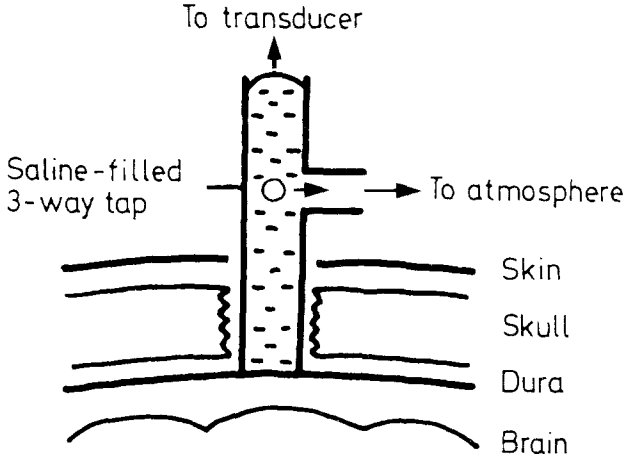

Fig. 1. Epidural tap

edges held back. This manoeuvre stops scalp edge bleeding. The hole is drilled at right angles to the bone using a Scoville Centring drill fitted to a Hudson brace. (Downs Ltd., Mitcham, Surrey, UK, Catalogue No. JJ185Q). This drill, is the key to the procedure, being an 8-mm twist drill with a slightly blunted tip, whose depth can be set up to 57 mm by loosening a 1/16 Allen screw. With experience the length of the drill can be set to 1 cm in a normal sized male and the hole drilled until there is a slight give as the inner table is penetrated. Less experienced operators can start by drilling a shallower hole initially and then deepening it at 1–2 mm intervals until through the inner table. Having perforated the inner table the hole is washed out copiously with saline until bleeding has ceased. Troublesome bleeding, which has been rare, can be stopped by filling the hole with bone wax then drilling the wax out again. With haemostasis achieved the lower end of a three way stopcock is pushed firmly into the hole. The external diameter of the stopcock can vary slightly and if difficulty pushing the stopcock is encountered then the upper edge of the hole may be enlarged with the drill bit. With the stopcock pushed in firmly, one or two taps on the end of it using the handle of the Hudson brace will wedge it firmly in the hole. The wound is then closed in a single layer of sutures, one of which is tied over the stopcock to anchor it into position.

The stopcock is filled with saline and connected to an external transducer. The zero reference point is at the level of the twist drill hole, and the zero must be checked whenever the head position varies. A variety of transducer types have been used with little difference between each type.

Occasionally the tracing will be damped due to partial blocking of the stopcock. This can be cleared by very gentle irrigation using 0.5 ml of normal saline or heparinized saline. This rarely has to be carried out more than once in twenty-four hours and is usually performed by the medical staff. Zero is checked after flushing.

The stopcock is removed simply by pulling it out of the hole. The skin edge where it passed through the scalp may be approximated with a suture of steristrips.

Results

Twenty-seven patients have been monitored using this technique for periods ranging from 12 to 5 days. The majority have had head injuries although they have also been inserted to monitor post-operative patients who have been ventilated, and patients with severe meningitis and post sub-arachnoid haemorrhage. The monitors have been inserted by neurosurgical senior registrars, registrars and non-surgically experienced house officers.

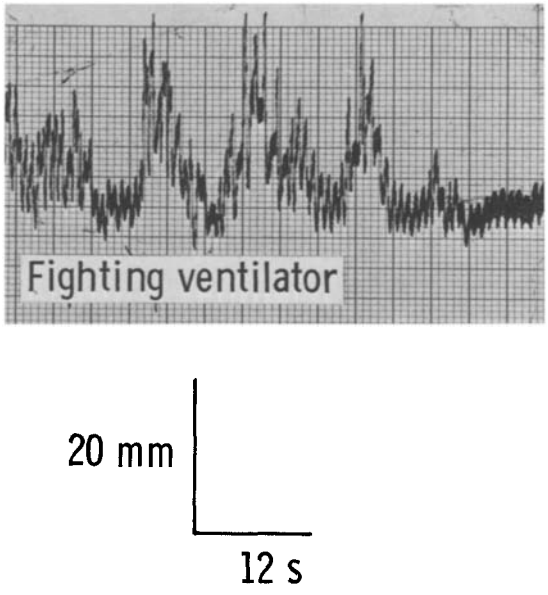

Fig. 2. A typical epidural tap pressure trace

Figure 2 illustrates a typical trace. In two patients comparison with a Gaeltec extradural transducer inserted over the opposite hemisphere was carried out giving identical wave forms and mean pressures.

Complications have been few. Two taps became blocked by a blood clot. One could be gently flushed clear, while the other was removed and replaced without the need to re-open the wound fully. Patency of the system can be checked by watching a rise in pressure in response to jugular venous compression. One tap fell out but since the stopcocks have been tapped in with the brace this has not been a problem. There have been no infections, extradural haematomas or c.s.f. leak from dural penetration.

Discussion

All current methods of intracranial pressure measurement have disadvantages which discourage their use outside of Neurosurgical Units, yet a case can be made for measuring intracranial pressure in all patients on a ventilator who may have problems with intracranial hypertension. This group includes ventilated cardiac arrests, overdoses, head injuries, encephalopathies and cases of drowning [5]. The majority of these will be handled in General Intensive Care Units without neurosurgical back-up.

Ventricular cannulation, undoubtedly the most accurate of methods of intracranial pressure measurement, requires a burr hole to be made, the dura opened and then the ventricle which may be small or

distorted to be cannulated. Difficulty may be encountered cannulating the ventricle and there are small risks of intracerebral haemorrhage along the needle track [7]. There is also a risk of ventriculitis quoted as up to 10% [6, 7], and the infective risks limit the duration of monitoring to 72 h.

The subdural 'bolt' requires opening of the dura and the arachnoid. There is a risk of haemorrhage around the cannula and of swollen brain blocking it. Leakage of c.s.f. around the bolt gives a risk of meningitis similar to the ventricular cannula [7]. Extradural transducers tend to be expensive and require stripping of the dura around a burr hole site for 1 to 2 cm. There is a risk of this manoeuvre causing an extradural haematoma, a situation which has been seen in this unit.

The extradural stopcock is easy and safe to insert thanks to the guarded drill. The dura remains closed so there is no risk of meningitis and as it does not have to be stripped away there is little risk of post insertion extradural haematoma.

Extradural pressure has been shown to correlate well with intraventricular pressure and for every day management where pressure trends are more important than absolute values, the extradural route is adequate [1, 2]. It may be argued that an extradural monitor measures not the intracranial pressure but the intracranial pressure modified by the elasticity of the dura. Comparisons between extradural pressure and intraventricular pressure have been made [1, 2] and shown to correlate well within clinically encountered pressure ranges. In every day management absolute values of intracranial pressure are not as important as pressure trends and for these the extradural route is adequate.

As most hospitals will have a Hudson Brace somewhere in its operating theatre the only special equipment which must be purchased is a Scoville Centring drill, which at the time of writing costs approximately £ 15.00, and a 1/16th Allen Key (not supplied with the drill!). Therefore for a minimal cost and with a minimal risk to the patient intracranial pressure readings can be obtained in a General Intensive Care Unit without access to neurosurgeons.

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