Profound hypotension: ethical considerations

Andrew G Jones

The use of profound induced hypotension to provide better operating conditions for surgery is long established. However, it is a controversial technique and it may be argued that it is inappropriate in modern anaesthetic practice. A currently used technique is reviewed against the benchmark of a lawsuit concerning profound hypotension.

The use of induced hypotension has a long history. It is used to reduce bleeding during surgery. It should be remembered, of course, that bleeding is the result of cutting blood vessels (Atkinson et al, 1987). However, numerous techniques have been used to reduce surgical bleeding. The justification has been to improve surgical outcome, for instance in the treatment of burned pilots during the second world war. Profound hypotension has been dubbed 'physiological trespass' (Gillies, 1950); how can the associated risks be justified? As ever risk–benefit analysis is complex. The application of profound hypotension to a particular surgical technique helps analysis and this is the approach which will be used.

BACKGROUND

In the Saint Paul's Eye Unit of the Royal Liverpool University Hospitals, profound hypotension (to one third of normal systolic pressure) is used to facilitate trans-scleral local resection of choroidal melanomas. This procedure generates some controversy; how can the practitioners of this technique demonstrate their ethical probity? Most medical ethical dilemmas are ultimately adjudicated in the law courts. The case of *Hepworth* v *Kerr* (Barton, 1996) provided an opportunity to compare practice with established legal precedent.

HEPWORTH V KERR

Dr Kerr practiced anaesthesia during the 1960s and 1970s. He provided anaesthesia for middle ear procedures and to produce what he considered ideal operating conditions he would provide profound hypotension (40 mmHg and sometimes as low as 20 mmHg systolic). He used this technique on more than 1000 occasions without ill effects and published his technique (Kerr, 1977).

Unfortunately, a patient of Dr Kerr's developed the profoundly disabling anterior spinal artery syndrome after profound hypotension for an operation in 1979. He was left with paraplegia and urinary and faecal incontinence. Legal proceedings were brought and the court found for the litigant. The case of *Hepworth* v *Kerr* is of great importance to practitioners of profound hypotension. The case raised a series of questions which must be considered before the use of profound hypotension (Simpson, 1996).

Was Dr Kerr justified in reducing the patient's blood pressure to 40 mmHg or even lower for 1.5–2 hours in 1979?

It is commonly taught that profound hypotension should only be used to make an impossible operation possible. Expert advice was given to the court that Mr Hepworth's surgery (revision mastoidectomy) did not require this profound degree of hypotension. Indeed a higher pressure was desirable to identify bleeding points, allowing haemostasis and thus preventing reactive postoperative haemorrhage. It transpired that hypotension was provided solely on Dr Kerr's initiative and not after discussion with the surgeon. Dr Kerr did not seek informed consent from his patients although he realized that he was performing a risky procedure. The court was extremely critical of these aspects of Dr Kerr's practice.

Choroidal melanoma is a malignant tumour which has traditionally been treated by enucleation of the eye. The Ocular Oncology Service of the Saint Paul's Eye Unit, under the direction

Dr Andrew G Jones is Consultant Anaesthetist in the Department of Anaesthesia, Royal Liverpool University Hospitals Trust, Liverpool L7 8XP

of Professor BE Damato, offers a range of options which are designed to adequately treat the tumour while preserving the eye, with retention of useful sight. The treatment requiring profound hypotension is termed local resection, and is applied only to large diameter tumours (9–15 mm) where enucleation is the only alternative. A partial scleral flap is raised and the tumour excised.

During the excision the eye is open, therefore the cut vessels must be perfused at atmospheric pressure or lower to prevent bleeding. Bleeding is disastrous for microsurgery. Bleeding obscures the field, preventing successful resection, and may cause postoperative retinal detachment. It has been demonstrated empirically that a pressure in the radial artery of 40 mmHg (or one third of usual systolic pressure) results in a suitable choroidal vascular pressure (Todd and Colvin, 1991). Consequently, this operation is technically feasible only with profound hypotension.

For some patients this operation offers the best chance of curative surgery with preservation of the eye. Thus they have a choice between safer anaesthesia with loss of the eye or greater risk to preserve the eye. They are therefore counselled as to the risks and make an informed decision as to which surgical operation to have.

Patients are told of the risk of death, brain damage, spinal cord damage and heart attack. Approximately 300 patients underwent this procedure in Professor Damato's previous unit in Glasgow (BE Damato, personal communication, 1994) and almost 200 in the author's unit (unpublished audit data). No serious complications have been seen. Using the 'rule of three' (the 95% confidence limits for an event which has not yet happened) (Eypasch et al, 1995) this gives a risk of 0.6% of a serious event. The patients are told that they have a 0.5% chance of any of the above complications happening and give informed consent on that basis.

The decision to proceed to local resection is based on surgical and physiological factors and the decision is made by surgeon and anaesthetist in collaboration.

Did the fact that Dr Kerr had published his technique in a learned journal justify its use scientifically?

Although Dr Kerr had published a limited series of patients as a clinical report no scientific data were included in the paper. The technique was not taken up by other anaesthetists. Therefore there was no scientific validity to this technique (Simpson, 1996).

Was Mr Hepworth's anterior spinal artery syndrome a direct result of the profound hypotension?

For Mr Hepworth's case to succeed causality had to be demonstrated as well as negligence. It was felt, and most clinicians would agree, that such a degree and duration of hypotension was the cause of Mr Hepworth's disability.

In the normal conscious patient the cerebral flow is subject to autoregulation. Within a range of blood pressures the cerebral flow remains constant and appropriate to the brain's metabolic needs whatever the blood pressure. Autoregulation is lost if the mean blood pressure falls below 60 mmHg.

However, it is of interest that Dr Kerr employed a head-up tilt as well as hypotension; yet the spinal cord infarcted, not the brain (Powers and Branthwaite, 1996). However, the position is clear; if a complication occurs after hypotension, causation is accepted. The anaesthetist's defence is that he or she was not negligent.

No head-up tilt is used during local resection of choroidal melanoma.

Was Mr Hepworth fit for hypotension?

Mr Hepworth was a middle-aged, hypertensive smoker. Dr Kerr made no attempt to warn him that he might be at higher risk or to modify his technique to allow for this. In the author's unit patients are selected for cardiovascular fitness. Although controlled hypertension is not a contraindication to hypotension, such patients are warned that their risk is unquantifiably higher than normotensive patients. The degree of hypotension is to one third of their systolic pressure, rather than an arbitrary figure. This gives a similar surgical field to that achieved in normotensive patients at 40 mmHg.

What standard of intraoperative monitoring was appropriate in 1979?

The judgment found that Dr Kerr's monitoring standards were inadequate even by the standards pertaining in 1979. Thus, there is a clear duty for the anaesthetist to monitor the patient as closely as possible within current technological limits. For profound hypotension in the Saint Paul's eye unit, V5 ST segment, cerebral function analysis and direct intra-arterial pressure are monitored in addition to the standard minimal monitoring requirements. The integrity of the spinal cord is not yet monitored, as direct stimulation is thought to be unnecessarily invasive. A system is being developed using surface stimulation with evoked potential detection using the cerebral function monitor.

DISCUSSION

From the case of *Hepworth* v *Kerr* arise several standards for ethical practice of profound hypotension. Informed consent is the bedrock. The patient must understand that an eye-preserving procedure caries a clearly higher risk than enucleation and they must consider that the risk is worth taking. The doctor must be satisfied that the patient truly understands the risks and accepts them. The author's practice is to quantify the risk based on the number of similar procedures carried out. There are very few external data available.

There is an obligation to use the most comprehensive monitoring available. Intra-arterial pressure monitoring is mandatory and ST segment measurement is very helpful, particularly with trend analysis.

The major problem is of central nervous system (CNS) monitoring. There is no method currently available for monitoring tissue perfusion throughout the CNS. Near infra-red spectroscopy shows only a small part of the brain and is impractical because of the need to share space with the surgeon. There are no published data on jugular bulb oxygenation in induced hypotension. Cerebral function and analysis monitoring (CFAM) provides global information, but will still not give data about regional hypoperfusion. However, global ischaemia is the most likely complication and should be detected by CFAM. In the Saint Paul's Eye Unit both cerebral hemispheres are monitored using a Maynard CFAM3C brain monitor. A raw electroencephalogram is monitored and spectral edge data are displayed as a trend. If the anaesthesia is kept at steady state, it may be assumed that any changes during hypotension are the result of ischaemia. It has been noted that the reduction in cerebral perfusion secondary to asystole of 20 seconds duration caused by the oculo-cardiac reflex was readily detected by the CFAM. This was at a stage of the procedure when the blood pressure was in the normal range.

Monitoring of the anterior spinal cord is very desirable but should not introduce other possible complications from invasive techniques. The ideal would be to administer a peripheral skin stimulus which could be detected as evoked potentials at the brain level by using the cerebral function monitor. Research is underway to develop this technique.

The anaesthetic technique should maximize tissue perfusion for a given level of hypotension. When different hypotensive techniques were compared, it was shown that use of a continuous infusion of a mixture of sodium nitroprusside and trimetaphan preserved or increased the cardiac output while reducing systemic vascular resistance. In contrast, use of isoflurane to produce hypotension reduced the cardiac output (AJ McClintick et al, unpublished data, 1990). However, it is possible that, at pressures as low as one third of systolic, perfusion will be lower than normal. Techniques which reduce oxygen requirements add to safety. Cardiac work may be reduced by using beta blockers and vasodilating agents; cerebral metabolic rate is reduced by isoflurane (Newberg et al, 1983).

The anaesthetist should have a very low threshold for elevating the blood pressure. As part of the preoperative counselling, the patient is reassured that in the event of any concern during hypotension the blood pressure will be brought up immediately, but that this may mean losing the eye.

CONCLUSION

There seems to be a growing public perception that all medical interventions should be risk free. On the contrary, all medical interventions should be subject to risk–benefit analysis. The author's patients believe that the increased risk of profound hypotension is worthwhile in order to save their eye from enucleation. HM

Conflict of interest: The author regularly performs profound hypotension so has a vested interest in demonstrating an ethical basis.

KEY POINTS

- Profound hypotension should be used to make an impossible operation possible.
- Patients must consent to the risk of death or disabling complications.
- Patient monitoring during hypotension should be of the highest standard.
- Blood pressure must be raised to normal immediately if any physiological variable is compromised.

Atkinson RS, Rushman GB, Lee JA (1987) *A Synopsis of Anaesthesia.* 10th edn. Wright, Bristol: 299

Barton A (1996) Introduction: *Hepworth* vs *Kerr*. *Clinical Risk* **2:** 73

Eypasch E, Lefering R, Kum CK, Troidi H (1995) Probability of adverse events that have not yet occurred: a statistical reminder. *Br Med J* **311:** 619–20

Gillies J (1950) Anaesthetic factors in the causation and prevention of excessive bleeding during surgical operations. *Ann R Coll Sur* **7:** 204–21

Kerr A (1977) Anaesthesia with profound hypotension for middle ear surgery. *Br J Anaesth* **49:** 477–52

Newberg LA, Milde JH, Michenfelder JG (1983) The cerebral metabolic effects of isoflurane at and above concentrations that suppress cortical electrical activity. *Anesthesiology* **59(1):** 23–8

Powers MJ, Branthwaite MA (1996) Forseeability and remoteness. *Clinical Risk* **2:** 85–7

Simpson PJ (1996) The risks of elective hypotensive anaesthesia. *Clinical Risk* **2:** 78–81

Todd JG, Colvin JR (1991) Ophthalmic surgery. In MacRae WR, Wildsmith JAW, eds. *Induced Hypotension.* Elsevier Science, London: 257–69