Is controlled hypotension to prevent intra operative bleeding different from the controlled hypotension to provide a bloodless surgical field?

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For 50 years, controlled or deliberate hypotension has been used to reduce intra operative bleeding and the need for blood transfusions. It has been indicated in spinal surgery and other neurosurgery (aneurysm), major orthopaedic surgery (hip or knee replacement, spinal), prostatectomy, cardiovascular surgery and liver transplant surgery. However a satisfactory bloodless surgical field is frequently also requested by the surgeons but less accepted by anaesthesiologists. This dry field is requested in oromaxillofacial surgery (mandibular osteotomy, facial repair), endoscopic sinus or middle ear microsurgery. Less invasive surgery today reduces the blood loss making the first indication questionable and the second more important. However a dry surgical field might require other approaches than just reducing blood pressure as a dry surgical field is also determined by the regional perfusion.

Controlled hypotension for blood loss reduction is defined as a reduction of the systolic blood pressure (SAP) to 80-90 mm Hg, a reduction of mean arterial pressure (MAP) to 50-65 mm Hg or a 30% reduction of baseline MAP. Blood loss by small arteries during surgical section causing blood loss and blood transfusion can be limited by reducing SAP. Several approaches are possible, reduction in cardiac preload is easy, reduction in contractility is difficult and dangerous but both should be avoided today as perfusion to vital organs is reduced. Agents used successfully in the past alone include high MAC inhalation anaesthetics, sodium nitroprusside, nitroglycerin. Reduction in heart rate helps to reduce MAP but increases SAP relative to MAP and is therefore not a good option either. Beta-adrenoceptor antagonists (beta-blockers) [e.g. propranolol, esmolol] and high dose opioids (e.g. remifentanil) reduce heart rate and cardiac output and are therefore not the first option. Arterial vasodilation with an increased peripheral perfusion is ideal and safe to reduce SAP and blood loss. Best agents today are the calcium channel antagonists, like nicardipine. It increases the organ perfusion with no bradycardia or tachycardia.

A dry surgical field with an optimal vision requires more than only hypotension. A reduced peripheral perfusion to the operated field is needed while maintaining sufficient perfusion to the vital organs.

Topical vasoconstriction is the best method to reduce local perfusion like in endonasal sinus surgery but should be assisted with a general anaesthesia.
that keeps this perfusion reduced. This is difficult as every region in the body reacts different on a reduction in cardiac output and blood pressure. Head and vital organs keep their perfusion while abdominal organs and skin are the first to vasoconstrict.

If “peripheral” surgery is required as on the non-critical organs, a small reduction in cardiac output and blood pressure will facilitate to get a blood free field by redirecting the flow to the critical organs. Vasodilation should be avoided as this re-opens the flow to the non-vital organs like the skin. Vasodilation by inhalation or nitroprusside only is therefore a bad choice. Remifentanyl reduces cardiac output and the peripheral perfusion in a dose related manner and was therefore the preferred choice until now.

If “central” surgery is required as on the head, oro-fascial or nasal region it is not possible to achieve vasoconstriction by a cardiac output drop only. These areas remain under good perfusion due to the nearby vital organs. Peripheral vasodilation now on the contrary will help to drawn the blood away from the vital organs but this is a more risky equilibrium and only possible in healthy individuals. Cardiac output should not increase to compensate the blood pressure drop but a decrease in cardiac output is less needed compared to peripheral surgery. Remifentanyl works here too due to its cardiac output decrease but only when combined with a vasodilator like inhalation or propofol.

There is no difference between desflurane sevoflurane and propofol in combination with remifentanil to obtain a successful hypotension with a bloodless surgical field, and there is frequently no need for additional use of a potent hypotensive agent. Postoperative morbidity (nausea, vomiting, shivering, pain, and oedema) was slight and did not differ among the 3 groups.

This protocol seems ideal but requires high dose remifentanil what is more and more questioned for several reasons. Moreover a dry central surgical field can also be obtained by other means. A first approach was adding clonidine pre operatively to facilitate controlled hypotension without remifentanil. The antihypertensive drug clonidine is a centrally acting alpha2 agonist useful as a premedicant because of its sedative, anxiolytic, and analgesic properties. Premedication with 300 ug clonidine reduced bleeding in middle ear microsurgery, attenuated hyper dynamic response to tracheal intubation, and reduced isoflurane, fentanyl, and urapidil requirements for controlled hypotension. However at this dose too much postoperative sedation is not acceptable either certainly in day case surgery.

Therefore Dexmedetomidine can be used in a loading dose of 0,5 to 1,0 ug/kg followed by a continuous infusion of 0,5 to 1,0 ug/kg/h. This makes it possible to work total opioid free. Dexmedetomidine gives bradycardia and vasoconstriction during loading followed by some vasodilation due to its strong sympathetic block. Ketamine is useful due to its vasoconstriction effect but this takes place only at hypnotic doses, what should be avoided due to the hallucinating disorders at this dose. At a low sub-hypnotic dose of 20 mg, ketamine helps to reduce the opioid needs but will have no hemodynamic effects.
Magnesium sulphate given as a bolus of 40 mg per kg followed by a 10 mg per kg per h infusion is also used to maintain a mean arterial pressure (MAP) between 60 and 70 mm Hg. Magnesium sulphate combined with sevoflurane provided adequate controlled hypotension and proper surgical conditions for middle ear surgery comparable to remifentanil. Magnesium sulphate had a more favourable postoperative course with better analgesia and less shivering and PONV than remifentanil.

Lidocaine intravenously in a dose of 1.5 to 3 mg/kg/h after a loading dose of 1.5 mg/kg has some slight vasoconstriction effects besides bradycardia and decrease in cardiac output. Note the amount of local anaesthetics used for infiltration and reduce accordingly. It helps to improve the vasoconstriction of the given local anaesthetics with adrenaline to maintain its effects.

With the use of such a multimodal approach it is possible to arise at a total opioid free anaesthesia for controlled hypotension. However one should take some aspects in consideration. Cardiac output might not drop enough therefore adding beta-blocker is useful certainly when tachycardia or adding nicardipine when MAP does not drop.

We can conclude with three options according the surgical requests.

Option three is new and will probably replace option two for a surgical dry field in the future.

Option one:
Anaesthesia induction with propofol, sufentanil and maintained with inhalation and opioids. Nicardipine to reduce SAP and only if real tachycardia adding some beta-blocker. Ideal for reducing blood loss, not useful to achieve dry surgical field. Esmolol allows easy control of beta blockade but is most of the time not required. Nicardipine should be given by bolus of 1 mg or in a continuous infusion.

Option two:
Anaesthesia induction with propofol, remifentanil and maintained with inhalation or continuous propofol infusion both combined with remifentanil infusion. Increase dose of remifentanil until desired drop in blood pressure and heart rate. No extra agents needed. Drop of cardiac output with some little vasodilation. Ideal for peripheral dry surgical field, but can also be used to obtain a central dry surgical field.

Option three:
Anaesthesia induction with dexmedetomidine, lidocaine and low dose ketamine followed by loading dose of magnesium. Maintenance of anaesthesia with continuous infusion of these four drugs and inhalation.
Adding nicardipine when MAP remains elevated and adding beta-blocker when also heart rate remains high and dexmedetomidine is already at 1 ug/kg/h. Ideal for a central dry surgical field. Esmolol as infusion is seldom required and nicardipine 1 mg is frequently enough.

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