Controlled hypotension Anesthesia

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Outlines

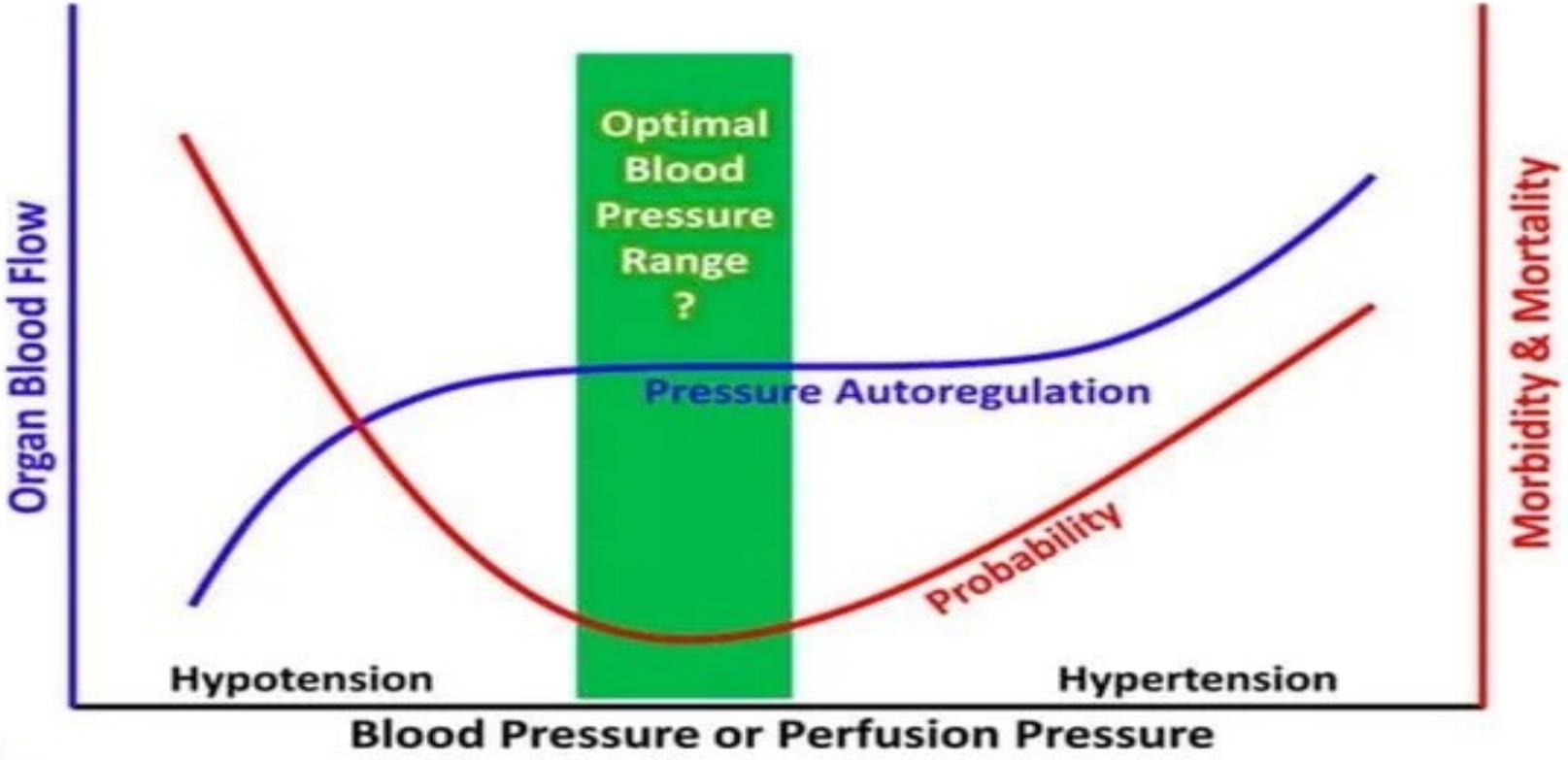
1. Introduction & History
2. Definition
3. Principle of hypotension
4. Technique
5. Anesthetic management

Introduction

- BP - One of the vital sign
- Normal BP – preserved CO and good organ perfusion
- Maintaining normotensive – skill of anesthetist

Review Article
Hypotensive Anesthesia versus Normotensive Anesthesia during Major Maxillofacial Surgery: A Review of the Literature

Perioperative blood pressure target



Lingzhong Meng. Hypertension. Blood Pressure Targets in Perioperative Care, Volume: 72, Issue: 4, Pages: 806-817, DOI: (10.1161/HYPERTENSIONAHA.118.11688)

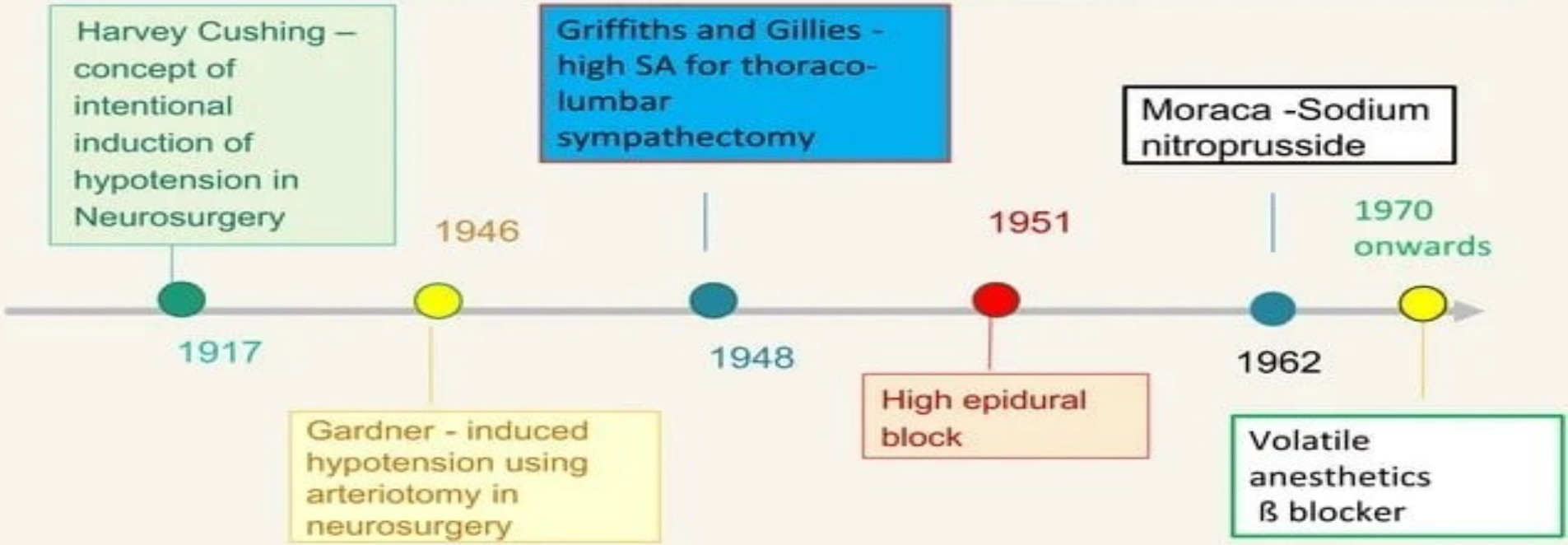
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Introduction

- WHY?
- Increase surgical field visibility
- To reduce blood loss
- Prevention of blood transfusion

Chandra .Induced Hypotension During Anesthesia, with Special Reference to Orthognathic Surgery

History and evolution of controlled hypotension



ASA- Deliberate Hypotension: A Historical Perspective(2010)
(http://www.asaabstracts.com/strands/asaabstracts/abstract.htm?year=2010&index=12&absnum=742)

DEFINITION

- Practitioner-initiated reduction of an anesthetized patient's BP to achieve a specific therapeutic purpose*
- No predefined fixed value
- Degree of hypotension is titrated until the desired level (for the surgical field) is obtained
- Within the safety limit of cerebral and coronary flow
- Individualized

- *Anesthesiology core review
- Surjya et al. Controlled hypotension in modern anesthesia: A Review and update(2015)

Cont.....

- Healthy patient(ASA I) defined as either reduction in :

SBP to 80-90 mmHg or

MAP to 50-65 mmHg or

30% of baseline MAP

} whichever is higher

(Barak M, 2015]; Strunin L, 1975; Lindop MJ, 1975)

- Elderly - MAP not less than 80 mmHg
- Chronic hypertensive pt - may not tolerate reduction of MAP > 25% of baseline

Principle of hypotension

Natural survival mechanism



Same principle is applied to surgery

Barack et al. Hypotensive Anesthesia versus Normotensive Anesthesia during Major Maxillofacial Surgery: A Review of the Literature (2015)

Hypoperfusion

Mainly to 3 organs



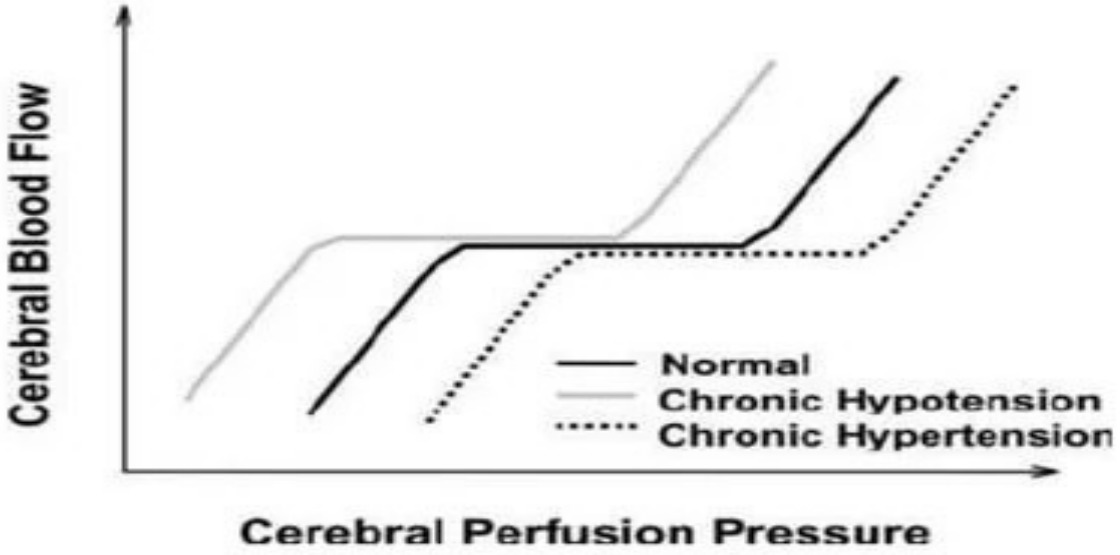
- Brain
- Heart
- Renal

Cerebral blood flow

Autoregulation

Normal CBF is maintained at 45-50 ml/100g/min

MAP = 50 - 150 mmHg



Factors influencing CBF

1) Volatile anesthetics

- Attenuates/ abolishes autoregulation
- Dose dependent: halothane > enflurane > isoflurane

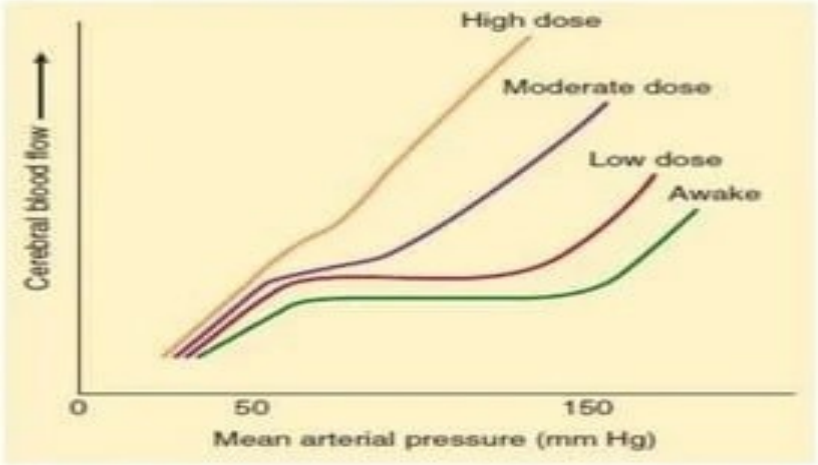
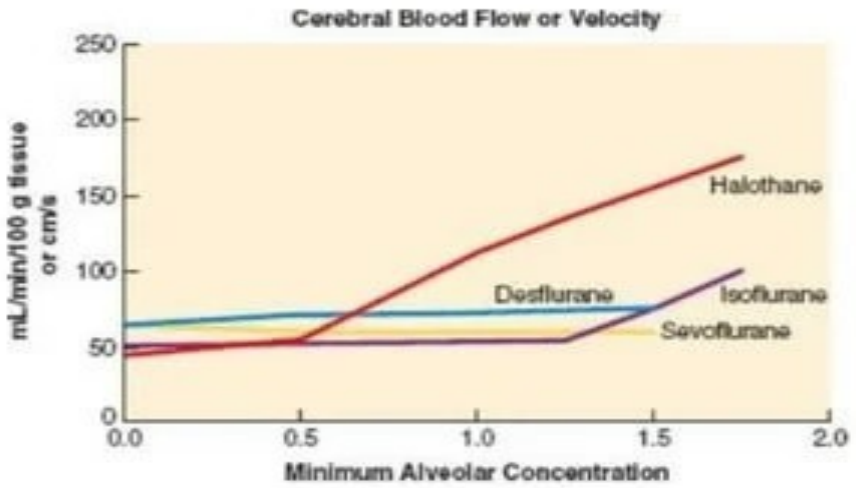


FIGURE 26–7 Dose-dependent depression of cerebral autoregulation by the volatile anesthetics.



Factors influencing CBF

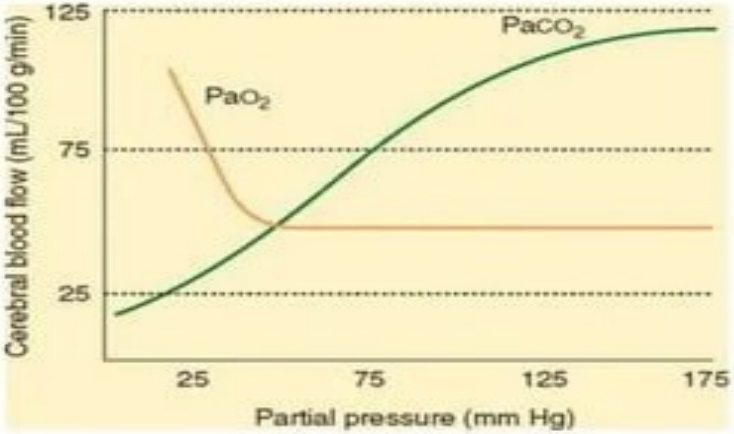
2) PaCO2

- ✓ Decreased – vasoconstriction

For every mm⬇ in PaCO2 - CBF ⬇by 2% in **normotensive** subjects

or

✓ for every mmHg⬆ in PaCO2 - CBF ⬆in the order of 1ml/100g/ml



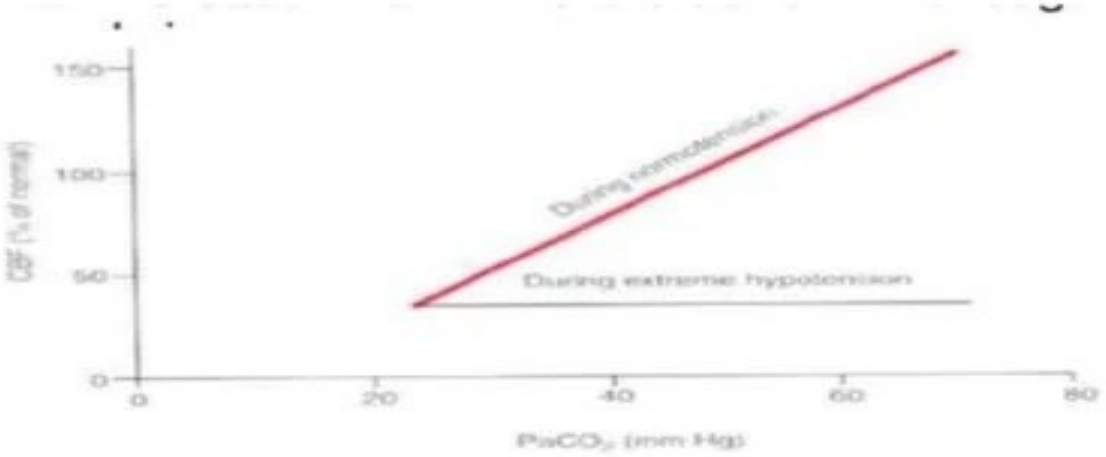
Source: Butterworth JF, Mackey DC, Wasnick JD: *Morgan & Mikhail's Clinical Anesthesiology*, 5th Edition: www.accessmedicine.com

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Factors influencing CBF

3) PaO2

- Administration of 100% O2 during induced hypotension not beneficial
- ⬇ CBF by ⅕ - toxic effect



Factors influencing CBF

4) Vasodilators

Attenuates autoregulation similar to volatile agents

5) Position

- For every 2.5 cm head raised - ⬇ CPP by 2 mmHg
- Head elevation in hypotensive anesthesia aggravates ⬇ CBF

Coronary circulation

- **Dependent on:**
  - Aortic diastolic pressure
  - Coronary vascular resistance
- Coronary blood flow autoregulation - changes parallel to demand
- **Hypotensive anesthesia** -
  - decreases coronary blood flow
  - decreases myocardial oxygen demand due to reduction in afterload (usually) or preload(sometimes)

Coronary circulation

- Patients with CAD:
  - areas of myocardium entirely dependent upon blood pressure to supply adequate blood flow
  - Steal phenomenon
- Significant risk of MI

Renal circulation

Autoregulation = 80-150 mmHg

MAP < 70 mmHg - decreases GFR

Opioids and inhalational stimulates ADH
- oliguria

Hepatic circulation

Liver is not autoregulated

Decreases in arterial pressure = decreases LBF

Increase in $PaCO_2$ /decrease in PaO_2 = catecholamine release → splanchnic vasoconstriction → decrease LBF

Respiratory circulation

Hypotensive anesthesia:

- ✓ PBF gravitates to dependent areas

- ✓ Vasodilators inhibits HPV → increases intrapulmonary shunts:
  - ➢ Hypercarbia
  - ➢ increased arterial-end tidal CO_2 gradient
  - ➢ hypoxia

Indications

- Major spine surgery
- Total hip arthroplasty
- orthognathic surgery
- middle ear surgery
- Radical neck dissection
- FESS
- Partial nephrectomy
- Major abdominal
- Endovascular aortic procedures
- Bloodless surgery

Contraindications

- Coronary artery disease
- Severe valvular heart disease
- congestive heart failure
- Poorly controlled hypotension
- Cerebrovascular disease
- Peripheral vascular disease
- Diabetes mellitus
- CKD

Techniques

MAP = CO x SVR

Key equation in providing hypotension anesthesia

MAP can be manipulated by increasing or decreasing CO or SVR or both

Table 2. Strategies for Inducing Controlled Hypotension

Category	*Strategy*	*Examples*
Decrease cardiac output	Reduce blood volume	Arteriotomy
	Dilate capacitance vessels	Nitroglycerin
	Decrease cardiac contractility	Inhalation anesthetics (eg, halothane), β-adrenergic blockers (eg, esmolol)
	Decrease heart rate	Inhalational agents, β-adrenergic blockers
Decrease peripheral vascular resistance	Block autonomic ganglia	Methonium compounds, pentolinium, trimethaphan
	Block α-adrenergic receptors	Phentolamine, labetalol
	Relax vascular smooth muscle	Direct-acting vasodilators (eg, nitroprusside), calcium-channel blockers (eg, nicardipine), purines (eg, adenosine), prostaglandin E_1, inhalational agents (eg, isoflurane)

Techniques

- Pharmacological
- Non- pharmacological

Pharmacological techniques

Ideal agent

- Easy administration
- Predictable effect
- Rapid onset & recovery
- quick elimination with no toxic metabolite
- minimal alteration in BF to vital organs

Pharmacological techniques

- Nitrates -Sodium nitroprusside (SNP),Nitroglycerin (NTG)
- Trimethaphan
- Calcium channel antagonists (e.g., nicardipine)
- β-adrenoceptor antagonists (e.g., propranolol and esmolol)
- ACEI
- α2- adrenoceptor agonists (e.g., clonidine and dexmedetomidine)

Commonly used drugs

Sodium Nitroprusside

- Direct vasodilator(Nitric oxide release)
- Dose - 0.5 -10 mcg/kg/min

Advantages

- Rapid onset(~1 min)
- Easy to titrate
- Increases CO
- Reversal is spontaneous

Disadvantages

- Cyanide/Thiocyanate toxicity
- Increased ICP
- Increased Pulmonary shunt
- Sympathetic stimulation
- Rebound hypertension
- Steal phenomenon
- Tachyphylaxis
- UV light break down(blue color)

Commonly used drugs

Nitroglycerin

- Direct vasodilator(Nitric oxide release)- predominately on capacitance vessels
- Starting dose - 1 -2 mcg/kg/min

Advantages

- Rapid onset(~1 min)
- easy to titrate
- limited increases HR
- No coronary steal phenomenon
- no upper limit - no toxicity reported
- No rebound phenomenon

Disadvantages

- increased ICP
- Increased Pulmonary shunt
- Methemoglobinemia
- Inhibits platelet aggregation
- Absorption by plastic

Commonly used drugs

Beta adrenergic antagonist

- Used alone or adjunct

Advantages	Disadvantages
➢ Rapid onset/offset ➢ limited increases HR ➢ No increased in ICP ➢ No pulmonary shunt	➢ Decreased CO ➢ Heart block ➢ Bronchospasm - asthma pt ➢ Limited efficacy when used alone

Commonly used drugs

Calcium channel blocker

- Vasodilator(vasodilate resistance but no effect on capacitance vessels)

Advantages

- ✓ Rapid onset/offset
- ✓ limited increases HR
- ✓ increased CO
- ✓ No effect on airway reactivity
- ✓ increase GFR/urine UOP

Disadvantages

- ✓ Prolong duration of action
- ✓ Increased ICP
- ✓ Increased pulmonary shunt

Commonly used drugs

Dexmedotomidine(α2 agonist)

Site of action:

- ✓ Brain(locus cereleus)
- ✓ Spinal cord
- ✓ Autonomic nerve

CNS effect:

- ✓ sedatives/hypnosis
- ✓ Anxiolysis
- ✓ Analgesia

Autonomic activity

- ✓ ⬇sympathetic activity
  decrease BP & HR

Disadvantages

- ➢ Prolong duration of action
- ➢ Increased ICP
- ➢ Increased pulmonary shunt

Commonly used drugs

Propofol

- Vasodilator

Advantages

- ✓ Rapid onset/offset
- ✓ Anti-emetic

Disadvantages

- ✓ PRIS
- ✓ Pain at injection site
- ✓ Increased pulmonary shunt

Commonly used drugs

Opioids

Alfentanil

Sufentanil

Remifentanil

- ✓ Rapid action
- ✓ Fast recovery

Micheal et al. Hypotensive Anesthesia versus Normotensive Anesthesia during Major Maxillofacial Surgery: A Review of the Literature

Commonly used drugs

Inhalation

Negative inotropic effect vasodilator

Advantages

- ✓ Provide surgical anesthesia
- ✓ Rapid onset/offset
- ✓ Easy to titrate
- ✓ Cerebral protection

Disadvantages

- ✓ Need high conc. When used alone
- ✓ Decrease CO
- ✓ cerebral vasodialation
- ✓ Shivering

Commonly used drugs

Neuromascular blocking agents

Tubocurarine

- **Ganglionic blockade**
- **Histamine release**

Vecuronium

Pancuronium – produces tachycardia

Micheal et al. Hypotensive Anesthesia versus Normotensive Anesthesia during Major Maxillofacial Surgery: A Review of the Literature

Non-Pharmacological techniques

Positional

- Elevation of site of operation- venous drainage
- Inclining 15-20°
- For each 2.5cm elevation above heart, BP drops 2 mmHg

Chandra .Induced Hypotension During Anesthesia, with Special Reference to Orthognathic Surgery

Non-Pharmacological techniques

Acute Normovolemic Hemodilutional (ANH)

- 1 or 2 units of pts blood drawn immediately before or shortly after induction of anesthesia
- Bleeds diluted blood
- After completion of surgery – retransfused autologous blood
- Prerequisite – Hb >= 12g/dL

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Non-Pharmacological techniques

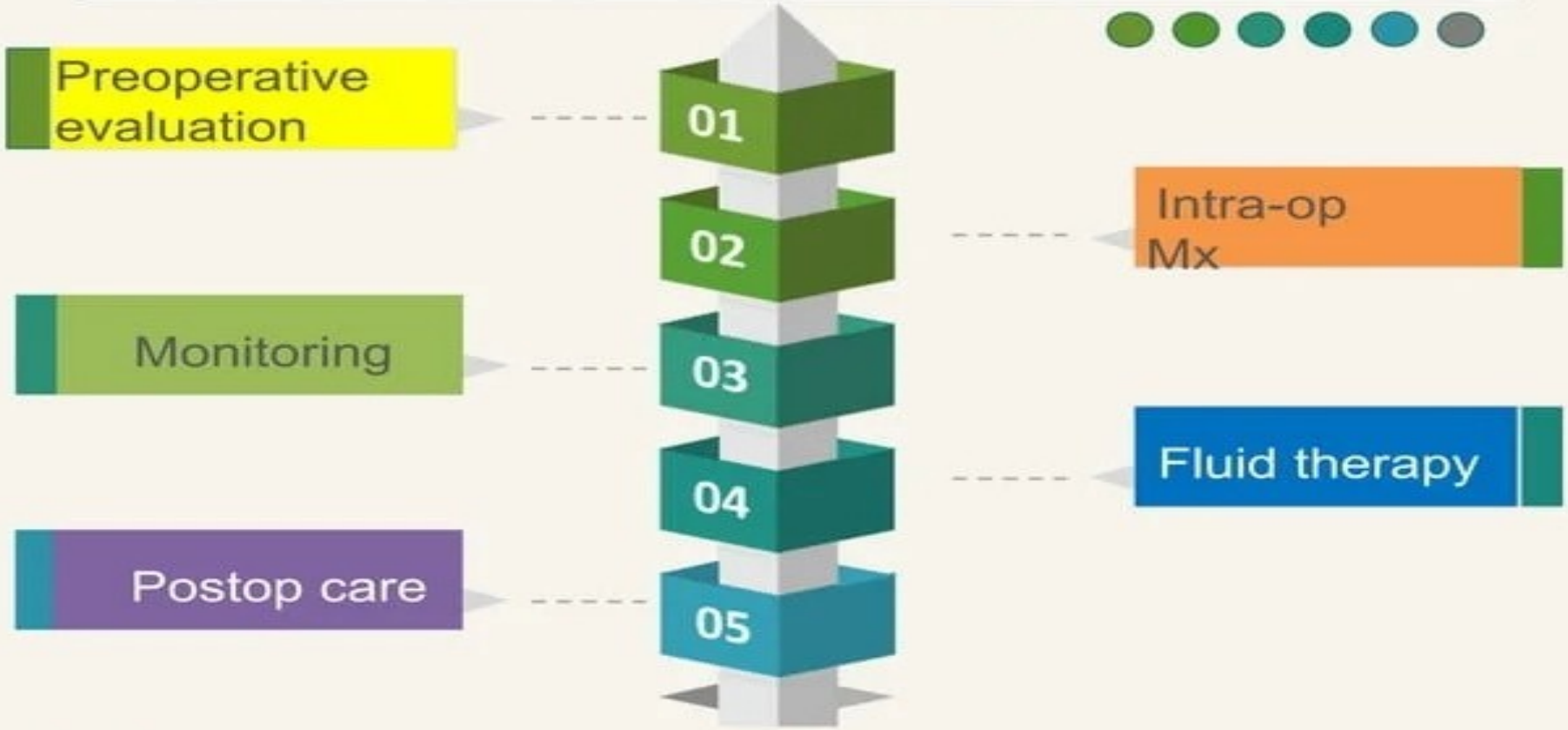
Positive airway pressure

- Decreases venous return
- Can be enhanced by:
  - increasing Vt,
  - prolonging inspiratory time
  - raising PEEP

Drawbacks:

- Deleterious effect on heart
- Increased dead space
- Increased CBF & ICP

Anesthetic management



Preoperative



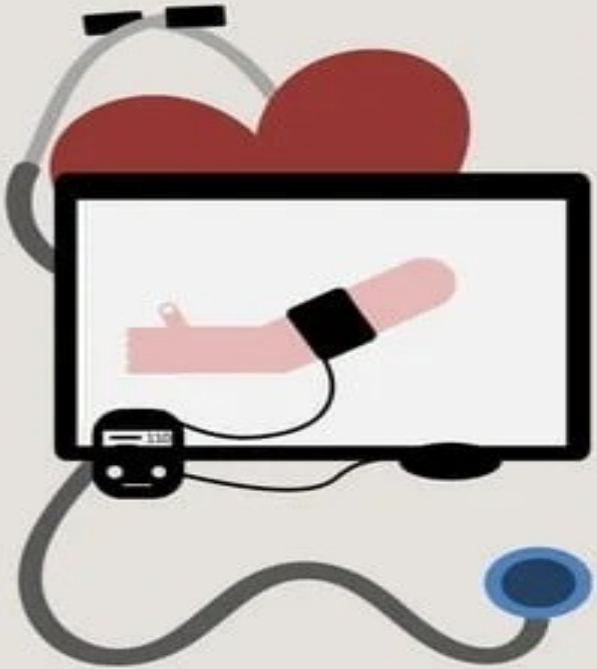
- Thorough knowledge by anesthetist
- Proper patient evaluation & selection
- Ix- Hb, urea, S/E, ECG
- Hb of 10g/dL
- Baseline ABG
- Premedication:
  - ✓ Anxiolysis
  - ✓ Analgesia
  - ✓ β & α blocker
  - ✓ Antihypertensive
- Vagolytics avoided

Intraoperative



- Stress free induction
- Enough PIV line
- NMB
- Pressure points
- - avoid nasal intubation

Monitoring



- Meticulous monitoring
- IBP
- NIBP - short surgery
- 5-lead ECG(V5)
- SpO2
- EtCO2
- Temperature
- CVP
- UOP
- Blood loss

Fluid Therapy



- Proper fluid therapy is essential
- Optimize fluid & electrolytes before Sx
- Maintenance fluid
- Blood loss replacement if exceeds 20 -25% of blood volume

Postop



- Rebound hypertension
- Reactionary hemorrhage
- Airway
- Analgesia
- Fluid balance

MCQ

Which of the following agents is not used to provide induced hypotension during surgery?

A. Sodium Nitroprusside

B. Hydralazine

C. Mephentermine

D. Esmolol

MCQ

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A. Sodium Nitroprusside

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D. Esmolol

Mephentaine is alpha & beta agonist – increses CO & BP

MCQ

Hypotension in anesthesia is induced all of the following drugs EXCEPT

A. Sodium Nitroprusside

B. Propofol

C. Pancuronium

D. Suxamethonium

E. Halothane

MCQ

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A. Sodium Nitroprusside

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MCQ

A healthy 60kg 52 year old woman undergoing reduction mammoplasty is anesthetized with isoflurane and oxygen, and deliberate hypotension to 80/40 mmHg is induced with nitroprusside. Urine output through an indwelling catheter has been 10 mL during the past hour. You should now

A. Administer furosemide 40 mg IV

B. Infuse NS until UOP reaches 35 mL/h

C. Expect normal urine flow with restoration of normal BP

D. Discontinue nitroprusside administration

E. Administer dopamine at 3mcg/kg/min

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THANK YOU