

Pathophysiology of hypotension

The leading cause of hypotension after the administration of SAB, with the potential risk of foetal placental hypoperfusion, is the immediate and extensive arteriolar vasodilation by the effect of preganglionic sympathetic blockade, leading to reduced systemic vascular resistance (SVR), potentiated by the increased sensitivity of nerve fibres to local anaesthetics during pregnancy [2, 8]. A complicating factor is that the degree of this sympatholytic response, often several dermatomes above the level of sensory blockade, tends to be individually unpredictable. Arteriolar vasodilation is accompanied by a mild degree of venodilation, but because blood volume increases approximately by 40-50% during pregnancy, and provided the pregnant patient is positioned to minimise the effects of aortocaval compression, there is no significant change in venous return. This explains why fluid therapy is only marginally effective in reducing the incidence and extent of hypotension in SAB in this situation. Furthermore, at the same time, it determines that vasopressors with sufficient alpha1-agonist action must be the mainstay for preventing and treating hypotension to ensure that SVR is restored to pre-SAB values in the first place.

Predicting the onset of hypotension

Hypotension after SAB administration occurs in up to 80% of parturients [2, 6], with severe hypotension (SBP <75% of baseline) occurring in up to 38% [7]. SAB itself is the most significant and sufficient predictor of the development of hypotension. Signs of autonomic instability and other risk factors should always be considered as additional preoperative predictors of hypotension following SAB in caesarean section [2, 9]:

- Baseline SBP <120 mmHg or a higher systolic-diastolic difference
- Higher heart rate variability before administration of the block
- High preoperative anxiety
- Sensory block level above T6
- Maternal age over 35 years old
- Infant weight greater than 4 kg
- Maternal height <155 cm
- Inexperienced anaesthesiologist
- Elective caesarean section (vs. acute, where the influence of labour and higher sympathetic tone is applied)

Prevention and treatment of hypotension

There has been a paradigm shift from treatment to prevention in relation to the management of hypotension after SAB in the delivery room. Proactive, or more precisely prophylactic, management is generally preferred to purely reactive management of pre-existing hypotension. Prophylactic interventions can be broadly divided into those that increase cardiac preload (fluid therapy, prevention of

aortocaval compression, and compression leg bandaging) and those that counteract afterload reduction and vasodilation (administration of vasopressors) [3].

If we rank the efficacy of each method according to their effectiveness in preventing hypotension, the order is as follows: *metaraminol* > *noradrenaline* > *phenylephrine* > *compression leg bandage* > *ephedrine* > *colloid given before SAB* > *colloid given after SAB* > *crystalloid given after SAB* > *crystalloid given before SAB* [1, 10].

Vasopressors are the basis of effective primary prevention of hypotension. Given the pathophysiology of hypotension in SAB – primarily arteriolar dilation – the alpha1-agonist effect of vasopressors is crucial. In our setting, ephedrine has historically been the number one vasopressor in obstetrics. However, ephedrine is predominantly a beta-adrenergic agonist with only a weak alpha-mimetic effect. Thus, experience and published data show that of the standard vasopressors used worldwide – ephedrine, phenylephrine, metaraminol, (noradrenaline) – ephedrine has the worst pharmacological and clinical results: the slowest and weakest onset of action, potentiation of tachycardia, and, in addition, it crosses the placenta with direct sympathomimetic effects on the foetus with adverse effects on foetal acidosis [11].

Vasopressors mediate their cardiovascular effects primarily by acting on alpha₁-, beta₁-, and beta₂-adrenergic receptors. Stimulation of each receptor leads to distinct physiological effects and reflex cardiovascular responses.

Phenylephrine is a pure direct alpha1-agonist. It is considered the standard for treating and preventing hypotension in obstetrics worldwide. However, unlike mixed agonists, it can (and does) induce baroreceptor-mediated bradycardia with a consequent reduction in maternal cardiac output [12]. This is a physiological response; therefore, baroreceptor activation and bradycardia are only transient but can be significant. Thus, concomitant administration of atropine may be appropriate in vegetatively unstable parturients.

Ephedrine has a rather indirect effect on adrenergic receptors but also a weak direct alpha1 effect, which explains the relatively slow onset and long duration of action. It usually also increases heart rate and contractility by stimulating cardiac beta1-adrenergic receptors [3]. Therefore, it is particularly suitable in parturients with slower heart rates or where its inotropic effect is preferable.

Metaraminol is a mixed alpha- and beta-agonist, but in clinically used doses, alpha effects predominate. When compared with phenylephrine, it may have a more favourable profile for preserving cardiac output by promoting cardiac positive inotropy and maintaining heart rate. It may be associated with the occurrence of reactive hypertension (too rapid a rise in BP) when given as bolus, so more careful titration is required than with phenylephrine [13]. Metaraminol is not currently available in our country.

Tab. 1. Adapted from Kinsella et al. [3]

	Receptor	Mechanism of action	Onset of action	Duration of action	Heart rate	Bolus	Initial continuous dose
Ephedrine	β1, β2, weak α	indirect, weak direct	slow (2–5 min)	prolonged	increased significantly	5–10 mg	x
Phenylephrine	α1	direct	rapid (1 min)	medium	reduced	50–100 µg	0.25–0.5 µg/kg/min
Metaraminol	α1, weak β1	direct and indirect	immediate	prolonged	increased	0.5 to 1 mg	0.6–2 µg/kg/min
Noradrenaline	α1, β1	direct	immediate	short	increased	5 µg	0.02–0.1 µg/kg/min