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Official Publication of the Brazilian Society of Anesthesiology  
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## CLINICAL INFORMATION

# Continuous spinal anaesthesia with minimally invasive haemodynamic monitoring for surgical hip repair in two patients with severe aortic stenosis<sup>☆</sup>

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Received 5 December 2012; accepted 20 March 2013

Available online 11 October 2013

### KEYWORDS

Anaesthetic techniques – subdural;  
Measurement techniques – cardiac output

### Abstract

**Background and objectives:** Aortic stenosis increases perioperative morbidity and mortality, perioperative invasive monitoring is advised for patients with an aortic valve area <1.0 cm<sup>2</sup> or a mean aortic valve gradient >30 mm Hg and it is important to avoid hypotension and arrhythmias. We report the anaesthetic management with continuous spinal anaesthesia and minimally invasive haemodynamic monitoring of two patients with severe aortic stenosis undergoing surgical hip repair.

**Case report:** Two women with severe aortic stenosis were scheduled for hip fracture repair. Continuous spinal anaesthesia with minimally invasive haemodynamic monitoring was used for anaesthetic management of both. Surgery was performed successfully after two consecutive doses of 2 mg of isobaric bupivacaine 0.5% in one of them and four consecutive doses in the other. Haemodynamic conditions remained stable throughout the intervention. Vital signs and haemodynamic parameters remained stable throughout the two interventions.

**Conclusion:** Our report illustrates the use of continuous spinal anaesthesia with minimally invasive haemodynamic monitoring as a valid alternative to general or epidural anaesthesia in two patients with severe aortic stenosis who are undergoing lower limb surgery. However, controlled clinical trials would be required to establish that this technique is safe and effective in these type or patients.

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**PALAVRAS-CHAVE**

Técnicas anestésicas  
– subdural;  
Técnicas de  
mensuração – débito  
cardíaco

## Rauianestesia contínua com monitoração hemodinâmica minimamente invasiva para cirurgia de reparação do quadril em dois pacientes com estenose aórtica grave

**Resumo**

*Justificativa e objetivos:* A estenose aórtica aumenta a morbidade e mortalidade no período perioperatório. A monitoração invasiva no perioperatório é recomendada para pacientes com área valvar <1,0 cm<sup>2</sup> ou gradiente médio >30 mm Hg, além de ser importante evitar a hipotensão e arritmias. Relatamos o manejo anestésico com o uso de rauianestesia contínua e monitoração hemodinâmica minimamente invasiva em duas pacientes com estenose aórtica grave, submetidas à cirurgia de reparação do quadril.

*Relato de caso:* Duas pacientes com estenose aórtica grave foram programadas para cirurgia de reparação de fratura de quadril. Rauianestesia contínua com monitoração hemodinâmica minimamente invasiva foi usada para o manejo anestésico de ambas as pacientes. A cirurgia foi realizada com sucesso após duas doses consecutivas de 2 mg de bupivacaína isobárica a 0,5% em uma das pacientes e quatro doses consecutivas na outra. As condições hemodinâmicas permaneceram estáveis durante a intervenção. Os sinais vitais e parâmetros hemodinâmicos permaneceram estáveis durante as duas intervenções.

*Conclusão:* Nosso relato descreve o uso da rauianestesia contínua com monitoração hemodinâmica minimamente invasiva como uma alternativa válida para a anestesia geral ou peridural em duas pacientes com estenose aórtica grave, submetidas à cirurgia de membro inferior. Contudo, ensaios clínicos controlados são necessários para estabelecer que a técnica é segura e eficaz nesse tipo de pacientes.

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**Introduction**

Severe aortic stenosis is defined as an aortic valve area less than 0.8 cm<sup>2</sup> and a transvalvular peak gradient greater than 80 mmHg.<sup>1</sup> Patients often presented with dyspnoea, angina and syncope on exertion. We can find patients with uncorrected severe aortic stenosis submitted to non-cardiac surgery. In these cases, anaesthetic considerations involve maintenance of sinus rhythm, normal heart rate and intravascular volume, and avoidance of hypotension. Severe hypotension can lead to coronary hypoperfusion and ventricular failure. Central blocks have been traditionally contraindicated in these patients.<sup>1</sup> Nevertheless, continuous spinal anaesthesia (CSA) may be of particular interest in patients with severe aortic stenosis, since it allows individualized titration of local anaesthetic and can provide greater haemodynamic stability than single-injection spinal anaesthesia.<sup>2–4</sup> CSA has been successfully employed in patients in whom haemodynamic stability is mandatory, as in patients with cardiac pathology undergoing lower limb surgery,<sup>5–7</sup> or obstetric procedures.<sup>8–9</sup>

We report the anaesthetic management with CSA and minimally invasive haemodynamic monitoring of two patients with severe aortic stenosis undergoing surgical hip repair.

**Case report****Case 1**

A 92-year-old woman was scheduled for left hip fracture repair after a left pertrochanteric femur fracture. In

her past medical history we found hypertension, severe aortic stenosis and moderate mitral regurgitation. Her pre-operative treatment consisted in Eplerenone, Aspirin and Furosemide. She had no known drug allergy.

We performed an echocardiogram before surgery, which revealed an aortic valve area of 0.6 cm<sup>2</sup> and a peak aortic transvalvular gradient of 85.4 mmHg, added to an ejection fraction of 63% and a double mitral impairment, with moderate mitral stenosis and severe mitral regurgitation. ECG showed normal sinus rhythm.

Once in theatre, we monitored the patient with ECG, non-invasive blood pressure (NIBP) and peripheral oxygen saturation (SO<sub>2</sub>). Basal values were: NIBP 150/78 mmHg; heart rate (HR) 89 bpm, SO<sub>2</sub> 100%. We inserted an arterial catheter in the left radial artery with the patient awake and slightly sedated using midazolam 0.05 mg kg<sup>-1</sup> IV and 50 µg IV fentanyl; we connected the catheter to a FloTrac-Vigileo<sup>R</sup> (Edwards LifeSciences), and measured continuously Stroke Volume Index (SVI), Cardiac Index (CI) and Stroke Volume Variation (SVV). Basal values were SVI 24 mL m<sup>2</sup>, CI 2 L min<sup>-1</sup> m<sup>2</sup><sup>-1</sup>, SVV 8%. After recording measurements, we positioned the patient in right lateral decubitus. For the CSA, we used a Micro-Spinolong set (Polymedic<sup>R</sup>, Temena, France), in which the catheter is introduced into the subarachnoid space through a cannula that covers the needle and protects the catheter from deformation or kinking. We inserted the 27 G pencil point spinal needle at the L3–L4 vertebral interspace into the subarachnoid space. We removed the needle and advanced the 26 G cannula; through it, we inserted the 27 G catheter 4 cm into the subarachnoid space, and secured it to skin. We repositioned the patient supine and, after aspiration of cerebrospinal fluid (CSF) to confirm the correct placement

**Table 1** Minimally invasive haemodynamic parameters.

Time	SVI (mL/m <sup>2</sup> )		SVV (%)		CI (L min <sup>-1</sup> m <sup>2</sup> <sup>-1</sup> )	
	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2
Basal values before anaesthesia	24	65	8	6	2	5
After first bupivacaine dose	22	60	8	13	2	6
After last bupivacaine dose	21	60	8	19	1,8	3
Surgery starting	22	65	8	11	2	4
Surgery ending	24	54	8	9	2,1	4

SVI, Stroke Volume Index; SVV, Stroke Volume Variation; CI, Cardiac Index.

of the catheter, we injected 2 mg of isobaric bupivacaine 0.5%. Haemodynamic parameters maintained stable and the pin-prick test revealed a sensory block at T10 level. We injected a further 2 mg-dose 5 min later. After achieving a T8-sensory level of anaesthesia, and persisting good haemodynamic conditions, we positioned the patient for surgery.

The total procedure lasted 35 min. Vital signs and haemodynamic parameters remained stable throughout the intervention (Table 1). There was no need of additional doses of bupivacaine. We gave the patient a total fluid volume of 500 mL of lactated Ringer's solution, guided by haemodynamic parameters. Estimated blood loss was 300 mL.

After surgery, we removed the spinal catheter, and transferred the patient to the recovery room awake, alert and comfortable. Postoperative pain was well managed with patient-controlled analgesia using morphine, following local protocols. We discharged the patient from the recovery room 4 h later. There was no report of cardiovascular complication or post-dural puncture headache during post-operative stay.

## Case 2

A 66-year-old woman was scheduled for left hip fracture repair after a right pertrochanteric femur fracture. She was a smoker, and apparently had no other medical history. She had no known drug allergy.

In the preoperative physical examination we found a systolic murmur and cardiomegaly on chest X-ray. We decided to perform a preoperative cardiac evaluation and an echocardiogram. This revealed a severe aortic stenosis, with an aortic valve area of 0.45 cm<sup>2</sup> and a peak aortic gradient of 95 mm Hg, added to an ejection fraction of 73.1% and moderate mitral regurgitation. ECG showed normal sinus rhythm. The patient refused previous symptoms related to aortic stenosis.

Once in theatre, we monitored the patient with ECG, NIBP and peripheral oxygen saturation (SO<sub>2</sub>). Basal values were: NIBP 168/58 mm Hg; HR 72 bpm, SO<sub>2</sub> 98%. We inserted an arterial catheter in the left radial artery with the patient awake and slightly sedated using midazolam 0.05 mg kg<sup>-1</sup> IV and 50 µg IV fentanyl; we connected the catheter to a Flotrac-Vigileo<sup>R</sup> (Edwards LifeSciences), and measured continuously SVI, CI and SVV. Basal values were: SVI 65 mL m<sup>2</sup>, CI 5 L min<sup>-1</sup> m<sup>2</sup><sup>-1</sup>, SVV 6%. After recording measurements, we positioned the patient in left lateral decubitus. For the CSA, we used a Micro-Spinolong set (Polymedic<sup>R</sup>, Temena,

France). We inserted the 27 G pencil point spinal needle at the L3–L4 vertebral interspace into the subarachnoid space. We removed the needle and advanced the 26 G cannula; through it, we inserted the 27 G catheter 4 cm into de subarachnoid space, and secured it to skin.

We repositioned the patient supine and, after aspiration of cerebrospinal fluid to confirm the correct placement of the catheter, we injected 2 mg of isobaric bupivacaine 0.5%. Haemodynamic parameters maintained stable and the pin-prick test revealed a sensory block at L1 level. We injected three more 2 mg-dose every 5 min until we achieved a T8-sensory level of anaesthesia, persisting good haemodynamic conditions. After that, we positioned the patient for surgery.

The total procedure lasted 70 min. Vital signs and haemodynamic parameters remained stable throughout the intervention (Table 1). There was no need of additional doses of local anaesthetic. The total fluid volume was of 750 mL of lactated Ringer's solution, guided by haemodynamic parameters. Estimated blood loss was 400 mL.

Spinal catheter was removed after surgery. The patient was transferred to the recovery room awake, alert and comfortable. Postoperative pain was well managed with patient-controlled analgesia using morphine, following local protocols. The patient was discharged from the recovery room 4 h later. There was no report of cardiovascular complication or post-dural puncture headache during post-operative stay.

## Discussion

These are the first reported cases of severe aortic stenosis with hip fracture, which use CSA with minimally invasive haemodynamic monitoring.

In patients with severe aortic stenosis, an abrupt decrease in systemic vascular resistance (SVR) could be fatal. For this reason, general anaesthesia is generally recommended, or in any case, epidural block with progressive titration of local anaesthetic can be employed, to avoid a sudden drop in SVR.

Epidural block does not always offer a suitable anaesthesia in these surgeries, requiring higher doses of local anaesthetic, leading to haemodynamic alterations. CSA allows a progressive blockade instead, with an adequate anaesthetic level, using smaller doses of local anaesthetic, and leading to maintenance of haemodynamic stability. The catheter placement is technically easier, and with the aspiration of CSF we can have the certainty that it is well positioned; we cannot have this certainty using an epidural catheter.

Moreover, haemodynamic alterations derived from general anaesthesia's induction and maintenance and from intubation are avoided with the CSA.

The use of CSA in patients with aortic stenosis undergoing lower limb surgery is limited in the bibliography to the report of clinical cases, while its use with minimally invasive haemodynamic monitoring has not been documented yet. Fuzier and colleagues,<sup>5</sup> and Collard and colleagues,<sup>6</sup> showed that CSA in elderly patients presenting severe aortic stenosis is a safe and effective technique for hip surgery. Fuzier and colleagues reported two cases of the use of CSA for hip fracture repair. They used only standard monitoring, and showed haemodynamic stability in both patients, using a perfusion of lower dose of phenylephrine in one of them. Phenylephrine can restore peripheral resistance rapidly without any  $\beta$ -adrenergic side effects or tachycardia, which could be fatal in these cases. We considered a phenylephrine infusion after spinal blockade, but it was not necessary due to the maintained haemodynamic conditions of the patients.

Collard and colleagues, in two cases of hip surgery as well, used radial and pulmonary arterial catheters for monitoring, and showed haemodynamic stability during the procedure, without using vasoactive drugs. Nowadays, minimally invasive monitoring of cardiac output can represent a valid alternative to invasive procedure as pulmonary artery catheterization. Uncalibrated, pressure waveform-based monitors, as FloTrac-Vigileo<sup>R</sup>, have been well validated in literature<sup>10</sup> and they can guide intraoperative management needing only a radial artery catheterization.

In literature, there is a disparity in terms of dose of local anaesthetic and of intervals between them.<sup>3-6</sup> In most studies, doses ranged 2.5–5 mg of bupivacaine, with a 15-min interval. We choose a smaller dose (2 mg of isobaric bupivacaine) and a titration's interval of 5 min: we considered that 5 min was an adequate time to assess the sensory blockade. Moreover, haemodynamic monitoring allowed us to avoid cardiovascular impairment due to an excessive sympathetic blockade. After confirming haemodynamic stability and sensory level, we repeated the dose, until achieving good surgical conditions while maintaining haemodynamic stability. Further studies are required to determine the best dosing criteria and intervals. Furthermore, CSA with lower doses of local anaesthetic<sup>4-5</sup> may be a choice in other types of patient in which a sudden fall in blood pressure should be avoided, for example parturient, especially when presenting cardiovascular diseases.<sup>8-9</sup>

However, the use of CSA has potential risks that should not be forgotten. Major bleeding, in addition to the

vasodilatation produced by the blockade, could be fatal. In these conditions it could lead to a fatal cycle of hypotension-induced ischaemia, ventricular dysfunction, and worsening hypotension.

Our report illustrates the use of CSA with minimally invasive haemodynamic monitoring as a valid alternative to general or epidural anaesthesia in a patient with severe aortic stenosis who is undergoing lower limb surgery. However, controlled clinical trials would be required to establish that this technique is safe and effective in these type or patients.

## Conflicts of interest

The authors declare no conflicts of interest.

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