Case Report

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# Case report: Blood pressure variation during cardiopulmonary bypass in a patient with multiple sclerosis

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**Introduction and importance:** Multiple sclerosis is known to be associated with both sympathetic and parasympathetic cardiovascular autonomic dysregulation. Thus, patients with multiple sclerosis comorbidity represent a potentially challenging patient population in cardiac surgery, especially in on-pump operations. Despite this, very little is known about the hemodynamics during cardiopulmonary bypass and the optimal perfusion strategy for patients with multiple sclerosis undergoing cardiac operations.
**Case presentation:** In this report, the authors describe a patient with relapsing-remitting multiple sclerosis, who underwent successful triple valve operation for aortic and mitral stenosis and tricuspid valve insufficiency. Distinct blood pressure variations in form of temporary pressure dips were noted during total cardiopulmonary bypass time as well as during the reperfusion period.
**Clinical discussion:** Pressure variations were not attributable to surgical, pharmacological or perfusion-related manoeuvres. Thus, they most likely represent symptoms of cardiovascular autonomic dysregulation manifesting during cardiopulmonary bypass. In this patient, blood pressure variations terminated spontaneously and remained within an acceptable range without external correction.
**Conclusions:** When treating patients with multiple sclerosis comorbidity, the potential pressure variability due to cardiovascular autonomic dysregulation should be taken into consideration to avoid increased blood pressure volatility due to overcorrection or undercorrection during cardiopulmonary bypass.

**Keywords:** blood pressure management, cardiopulmonary bypass, extracorporeal perfusion, multiple sclerosis

## Introduction

Multiple sclerosis is the most common demyelinating neurological disorder and is frequently associated with cardiovascular autonomic dysregulation[1]. With increasing incidence and prevalence worldwide[2–4], it has become a non-negligible comorbidity in the cardiac surgery patient population as well. Especially orthostatic blood pressure dysregulation and altered blood pressure response to sympathetic or parasympathetic stimuli have been described[5]. Thus, patients with multiple sclerosis as a comorbidity are at least theoretically at higher risk for blood pressure dysregulation during cardiac surgery, especially when extracorporeal bypass is used. In contrast to that, multiple sclerosis associated blood pressure variation during cardiopulmonary bypass has not been reported to date.

### HIGHLIGHTS

- Since multiple sclerosis is the most common demyelinating neurological disorder, the majority of cardiac surgeons will sooner or later be challenged to operate on a patient with multiple sclerosis comorbidity.
- Multiple sclerosis is known to be associated with cardiovascular autonomic dysregulation, which may be relevant for blood pressure management during cardiopulmonary bypass.
- In the case presented here, periodical blood pressure dips were noted during total cardiopulmonary bypass and during reperfusion in a patient with multiple sclerosis comorbidity undergoing triple valve surgery.
- Blood pressure variations may be attributable to autonomic cardiovascular dysregulation as a symptom of the multiple sclerosis comorbidity.
- Surgeons, anesthesiologists, and perfusion specialists treating patients with multiple sclerosis comorbidity need to be aware of the potential pressure variability due to cardiovascular autonomic dysregulation during cardiopulmonary bypass to avoid blood pressure volatility resulting from over- or undercorrection.

## Case presentation

We present the case of a 60-year-old white female patient who underwent mechanical aortic and mitral valve replacement, as well as tricuspid valve reconstruction in cardioplegic arrest for third grade aortic and mitral valve stenosis and tricuspid valve insufficiency. She was referred to our specialized cardiac surgery

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centre by her general physician and presented with progressive shortness of breath over the last 6 months. The patient's height was 180 cm and her weight was 80 kg resulting in a Body-mass-index of 24.7 kg/m². Upon admission in the clinic, a sinus rhythm with a pulse frequency of 68 bpm and a blood pressure of 132/82 were found in the initial diagnostics. Transthoracic echocardiography revealed a preserved left ventricular systolic function with a left ventricular ejection fraction of 55%. Mitral valve stenosis with a functional opening area of 0.68 cm², combined aortic stenosis and insufficiency with a functional opening area of 1.00 cm², and grade 3 tricuspid valve insufficiency were found. There were no echocardiographic signs of pulmonary hypertension with a systolic pulmonary artery pressure of 18 mmHg. Cardiac index at rest was 1.9l/min/m². Preoperative coronary angiography revealed coronary sclerosis without significant stenoses. The patient was diagnosed with relapsing-remitting multiple sclerosis 20 years ago and was currently asymptomatic regarding the neurologic pathology under interferon beta treatment. She reported that she had not experienced symptomatic episodes of relapse within the last two years before surgery. Her further medical history was significant for hypothyroidism that was supplemented with Levothyroxine, and arterial hypertension that was treated with Candesartan and Metoprolol. She had not undergone previous surgical interventions and family and social history were without relevant findings. Furthermore, she reported that she had not experienced any symptomatic blood pressure variations to that point. She was employed in an office job and had two vaginal births without complications. Her family history was insignificant for multiple sclerosis or cardiovascular diseases. This case report is reported in line with the SCARE 2023 Criteria[6].

Interferon therapy was continued unchanged during the pre- and perioperative course. The lead surgeon of the procedure was a senior cardiovascular surgeon with extensive experience in the management of complex valvular heart diseases. The patient was placed in supine position. Continuous invasive blood pressure monitoring via the right radial artery was performed. For anaesthesia induction, 50 mg Rocuronium bromide as well as Etomidate and Midazolam was used. Balanced anaesthesia with Sevoflurane and Propofol was performed. Concerning catecholamine therapy, Norepinephrine administration remained unchanged at 200 µg/h during the operation and the early postoperative period until extubation. According to the standard protocol in our centre, no routine near-field infrared spectroscopy monitoring was performed. Full median sternotomy was performed. Total cardiopulmonary bypass was initiated following standard aorto-bicaval cannulation. Non-pulsatile cardiopulmonary bypass with a target flow of 4.66 l/min and mild hypothermia at a minimum temperature of 32°C was used. During total cardiopulmonary bypass, blood pressure variations were noted which appeared in the form of pressure drops of varying amplitude in a nearly periodic manner with dips after 2, 7, 12, 17, 23, and 28 min of total bypass time (Fig. 1A). These blood pressure variations were not attributable to surgical manoeuvres, cardioplegia, or variations in cardiopulmonary bypass perfusion rates. Likewise, no changes were made in the application rates of catecholamines or other potentially blood pressure-modifying drugs during total cardiopulmonary bypass time. Following the dips, blood pressure spontaneously rose back within one minute, again without any surgical, pharmacological, or perfusion-related intervention.

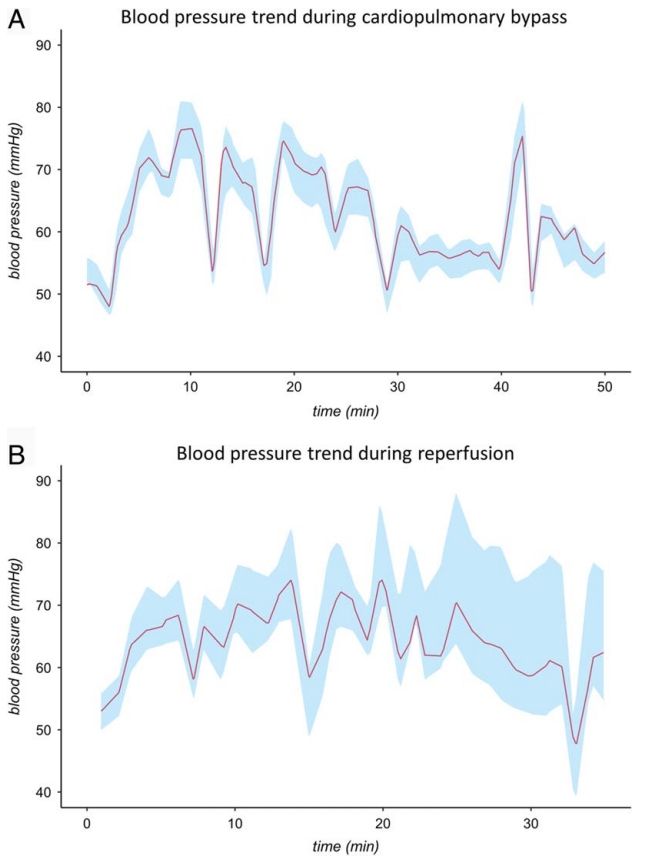


**Figure 1.** Blood pressure trends during the first 50 min of total cardiopulmonary bypass (A) and during reperfusion (B). Mean pressure (red line), as well as the pressure range between the minimum and maximum pressure (blue shading) were recorded for every minute by invasive blood pressure measurement.

A similar phenomenon was observed during the reperfusion period (Fig. 1B). Here, pressure dips were noted at 7, 15, and 31 min of reperfusion. During that period, no surgical manoeuvres were performed and cardiopulmonary bypass perfusion rate remained stable.

Total bypass time was 174 min. After weaning from cardiopulmonary bypass, no blood pressure fluctuations were observed and the further operative course was uneventful. and extubated on the first postoperative day. Postoperative hemodynamics and valve functions were satisfactory. Postoperative continuous invasive blood pressure monitoring was continued for the first 16 h after surgery. During this period, blood pressure remained within normal limits without relevant variations or dips. Except for a postoperative delirium, which resolved spontaneously within 3 days, there were no signs of adverse neurological events or relapse in the further postoperative course and the patient adhered sufficiently to the measures for postoperative mobilization and physical rehabilitation. From the perspective of the patient, the surgical and perioperative course was satisfactory. She was discharged from our centre on the eighth postoperative day with a normotensive blood pressure of 131 over 60 mmHg. As post interventional considerations, close blood pressure monitoring during possible subsequent cardiac and non-cardiac operations was recommended to the patient and stated in the clinical report.

## Discussion

Cardiovascular autonomic dysfunction in multiple sclerosis has been shown to be attributable to central nervous lesions one hand[1] and the peripheral autonomic nervous system due to altered parasympathetic baroreflex response and dysregulated sympathetic vasoconstriction on the other hand[7]. Both mechanisms may also explain the blood pressure variations observed in our patient during cardiopulmonary bypass. In the absence of other potential causes of temporary blood pressure variations, we conclude that the observed pressure fluctuations are most likely due to cardiovascular autonomic dysfunction in the context of multiple sclerosis, which becomes apparent during cardiopulmonary bypass. In our patient, cardiovascular autonomic dysfunction was not clinically evident prior to cardiac surgery. This is consistent with discoveries by Nordenbo and colleagues and Linden and colleagues who have shown that autonomic cardiovascular dysfunction can remain subclinical in patients with multiple sclerosis[8,9].

To our knowledge, this is the first description of increased blood pressure variability during cardiopulmonary bypass in the setting of multiple sclerosis. The exact processes underlying this phenomenon cannot be deducted from a case report and further research is needed to understand the exact pathophysiological mechanisms in this overall rare patient collective. Nonetheless, this example shows that multiple sclerosis as a systemic disease may influence intraoperative hemodynamics and thus needs to be taken into consideration when planning surgery for patients with a positive history for multiple sclerosis. This is of particular importance in the field of cardiovascular surgery, when extracorporeal perfusion is necessary, since maintaining a sufficient perfusion pressure during bypass is especially relevant for cerebral and renal perfusion[10,11]. In our patient, pressure variations did not require external pharmacological or perfusion-related corrections. Thus, knowledge of the possibility of the occurrence of usually transitory pressure variations in multiple sclerosis patients may also help to avoid hypervigilant overcorrection of the blood pressure during bypass. For this, a thorough assessment of the past medical history including the family history with respect to multiple sclerosis is essential[12]. Nevertheless, in another case report, Nikai and colleagues demonstrated the potential danger associated with vascular dysregulation of multiple sclerosis for patients undergoing cardiac surgery. They reported a patient with primary progressive multiple sclerosis who had an uncomplicated intraoperative course with uneventful cardiopulmonary bypass but who presented postoperatively with blood pressure fluctuations and eventually a lethal low-output syndrome, which the authors attributed to multiple sclerosis comorbidity[13].

## Conclusion and learning points

Cardiac surgeons, anesthesiologists, and perfusion specialists treating patients with multiple sclerosis comorbidity need to be aware of the potential pressure variability due to cardiovascular autonomic dysregulation during cardiopulmonary bypass. Increased intraoperative blood pressure volatility resulting from both, overcorrection and undercorrection, should be avoided in this challenging patient population.

## Ethical approval

Not applicable.

## Consent

Written informed consent was obtained from the patient for publication of this case report and accompanying images. A copy of the written consent is available for review by the Editor-in-Chief of this journal on request.

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None.

## Author contribution

C.K.: surgeon in charge, conceptualization, supervision, writing—review and editing; B.S.: anesthesiologist in charge, data acquisition, conceptualization, writing—review and editing; S.R.: assistant surgeon, data acquisition, conceptualization, writing—review and editing; F.H.: assistant surgeon, data acquisition, investigation, visualization, formal analysis, writing—original draft, writing—review and editing. All authors read and approved the final manuscript.

## Conflicts of interest disclosure

There are no conflicts of interest to disclose.

## Research registration unique identifying number (UIN)

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Dr. Florian Helms.

## Availability of data and materials

The datasets used and analyzed during the current study are available from the corresponding author on reasonable request.

## Provenance and peer review

Not commissioned, externally peer-reviewed.

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