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Case Report

Spinal anesthesia in a patient with Fabry disease and multiorgan involvement: a rare case with long-term success

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Abstract: Background: Fabry disease is a rare X-linked lysosomal storage disorder characterized by the progressive accumulation of globotriaosylceramide in various tissues. Disease progression can lead to complications involving multiple organ systems, most notably the heart, kidneys, nervous system, and eyes. General anesthesia can pose substantial risks in patients with Fabry disease due to cardiac hypertrophy, diastolic dysfunction, autonomic instability, and altered drug metabolism. Case: We report the case of a 57-year-old woman who required bilateral hallux valgus correction. The patient was receiving enzyme replacement therapy for Fabry disease and exhibited significant multiorgan involvement, as indicated by the presence of proteinuria (albumin-to-creatinine ratio, 1011.2 mg/g), concentric left ventricular hypertrophy (interventricular septal thickness, 14.3 mm), reduced global longitudinal peak strain (-11.2%), polyneuropathic symptoms, and ocular features. Outcome: To minimize anesthetic risks, spinal anesthesia was selected and administered without sedation. The procedure was uneventful, with the patient exhibiting stable intraoperative vital signs and making a full neurological recovery within 2 h. The patient experienced no anesthetic or surgical complications over the 2-year follow-up period. Conclusion: This case highlights spinal anesthesia as a potential anesthetic strategy for patients with Fabry disease and advanced systemic involvement. It emphasizes the importance of individualized perioperative planning and contributes valuable clinical evidence to the limited literature on spinal anesthesia in this high-risk population.

Keywords: Fabry disease, spinal anesthesia, cardiomyopathy, enzyme replacement therapy, lysosomal storage disorder

Introduction

Fabry disease is an X-linked lysosomal storage disorder caused by a deficiency of α-galactosidase A (α-Gal A), which results in the progressive accumulation of globotriaosylceramide (Gb3) in various tissues [1, 2]. The multisystem dysfunction caused by this accumulation most commonly affects the heart, kidneys, nervous system, eyes, and skin [3]. Clinical manifestations include neuropathic pain, gastrointestinal disturbances, angiokeratomas, cornea verticillata, cardiac hypertrophy and arrhythmias, progressive proteinuria, renal impairment, and cerebrovascular disease [2]. The development of cardiac and renal complications are key prognostic factors in Fabry disease.

Several clinical manifestations of Fabry disease can affect the patient's response to anesthesia. Left ventricular hypertrophy, arrhythmias, and valvular dysfunction, which are frequently observed in patients with Fabry disease, can result in significant hemodynamic instability during anesthesia [4, 5]. Progressive renal dysfunction and autonomic neuropathy further complicate perioperative management [6]. Despite this, the anesthetic management of patients with Fabry disease has been infrequently reported, with most cases described to date involving general anesthesia [7, 8]. Patients with Fabry disease present unique anesthetic challenges, owing to factors including cardiovascular instability, impaired autonomic regulation, delayed drug metabolism, and heightened sensitivity to sedatives. In indi-

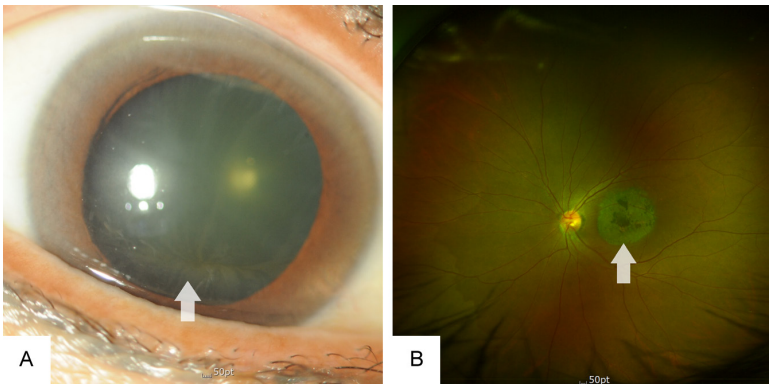

Figure 1. Composite ocular images in a patient with Fabry disease. A: Slit-lamp photograph showing whorl-like corneal opacities consistent with cornea verticillata. B: Wide-field fundus photograph demonstrating a central macular scar. The lesions are marked with arrows in each image.

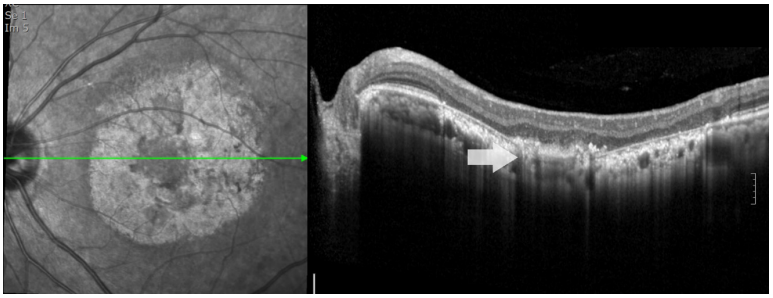

Figure 2. Optical coherence tomography (OCT) revealing foveal thinning and subfoveal scarring, consistent with retinal involvement in Fabry disease. The affected area is marked with an arrow.

viduals with left ventricular hypertrophy and diastolic dysfunction, perioperative fluid shifts can precipitate life-threatening complications such as cardiac arrest [9].

The use of spinal rather than general anesthesia in patients with Fabry disease offers the advantage of limiting systemic drug exposure, thereby reducing metabolic burden. Compared to general anesthesia, spinal anesthesia exerts less influence on cardiovascular and autonomic nervous system function [10, 11], making it a potentially safer alternative for high-risk patients.

In this study, we present the case of a female patient with Fabry disease and extensive systemic involvement who successfully underwent bilateral hallux valgus correction under spinal anesthesia without sedation. This case highlights the potential safety and clinical value of regional anesthesia in patients with Fabry disease and adds to the limited body of literature on this topic.

Case report

A 57-year-old female patient presented with blurred vision in the right eye and a foreign body sensation in the left eye. She had been diagnosed with choroidal neovascularization at an ophthalmology clinic 25 years earlier after experiencing visual disturbances in her left eye. She was diagnosed with Fabry disease at another institution 9 years prior to the current presentation after developing proteinuria, fatigue, bilateral hand numbness that interfered with sleep, and arthralgia. She had no known family history of Fabry disease. Since the diagnosis of Fabry disease, the patient has received intravenous Fabrazyme (37 mg) every 2 weeks as enzyme replacement therapy.

Slit lamp examination performed at presentation revealed cornea verticillata and fundus examination revealed a macular scar (**Figure 1**). Optical coherence tomography showed foveal thinning and scarring (**Figure 2**). Laboratory tests revealed serum creatinine and microalbumin levels of 78.83 μmol/L and 746.6 mg/L, respectively, representing an albumin-to-creatinine ratio (ACR) of 1011.2 mg/g. Electrocardiography demonstrated sinus bradycardia and left ventricular hypertrophy (**Figure 3**). Transthoracic echocardiography revealed an interventricular septal thickness (IVSd) of 14.3 mm, a left ventricular posterior wall thickness of 10.3 mm, an E/e' ratio of 17.2, and a global longitudinal peak strain (GLPS) average of -11.2%. These findings were indicative of concentric left ventricular hypertrophy, preserved left ventricular systolic function, and grade II diastolic dysfunction with elevated filling pressures. Additionally, subendocardial brightness was observed in the lateral basal wall (**Figure 4**).

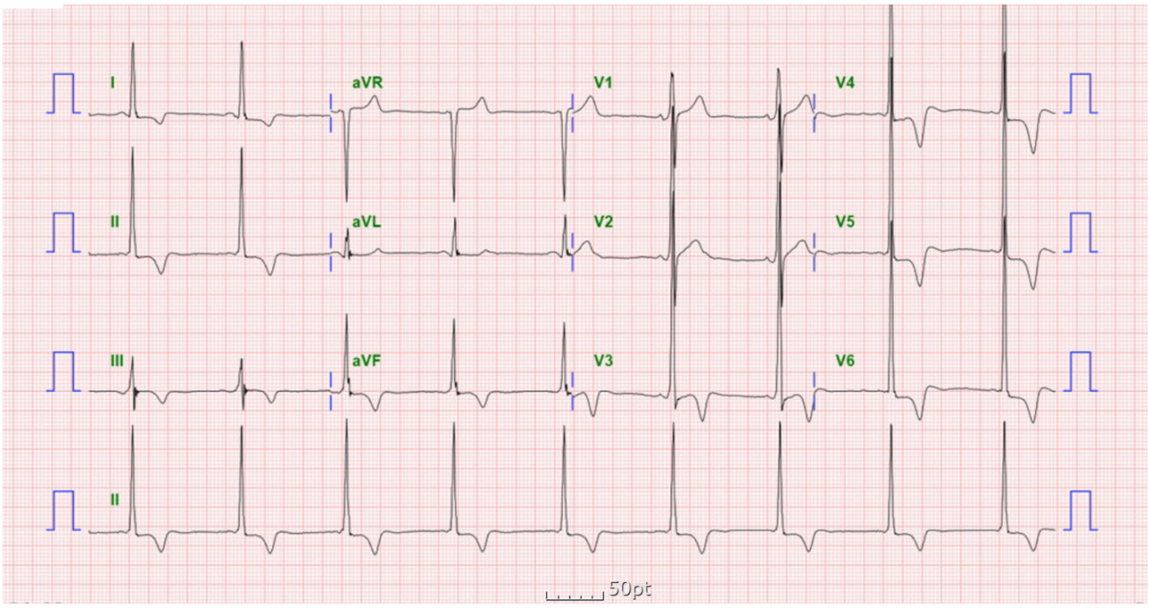

Figure 3. Electrocardiogram showing sinus bradycardia and left ventricular hypertrophy, typical of cardiac involvement in Fabry disease.

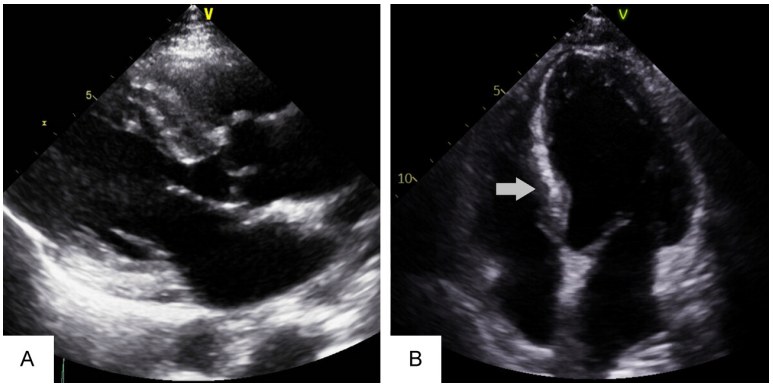

Figure 4. Transthoracic echocardiographic images in a patient with Fabry disease. A: Parasternal long-axis view showing concentric left ventricular hypertrophy. B: Apical four-chamber strain image demonstrating subendocardial brightness in the basal lateral wall. These findings are consistent with Fabry cardiomyopathy. The lesion is marked with an arrow.

Although pulmonary function test results were within normal limits, the patient reported a persistent dry cough and nocturnal wheezing lasting for over 6 months, which developed following an episode of common cold and coronavirus disease 2019 infection. The patient did not report any urinary disturbances or abnormalities in sweating. Neurological examination revealed no sensory or motor deficits, and nerve conduction studies and electromyography yielded unremarkable results.

The patient was therefore scheduled for bilateral hallux valgus correction surgery. After the relative benefits and risks of general and spinal anesthesia were fully explained to the patient, spinal anesthesia was chosen through shared decision making.

With the patient in the lateral decubitus position, the T10-S2 area was sterilized, and 40 mg 2% lidocaine was introduced into the subcutaneous tissue and muscle layer at the L4-L5 interspace. A 25-gauge Quincke needle was inserted via the median approach, and the appearance of clear cerebrospinal fluid was confirmed. Subsequently, 10 mg 0.5% bupivacaine was administered intrathecally. Sensory blockade up to the T6 dermatome was achieved within 5 min.

The patient remained awake but comfortable throughout the 40-min surgical procedure and was continuously monitored without sedation. Intraoperative vital signs recorded at 5-min intervals remained stable (**Figure 5**). Following

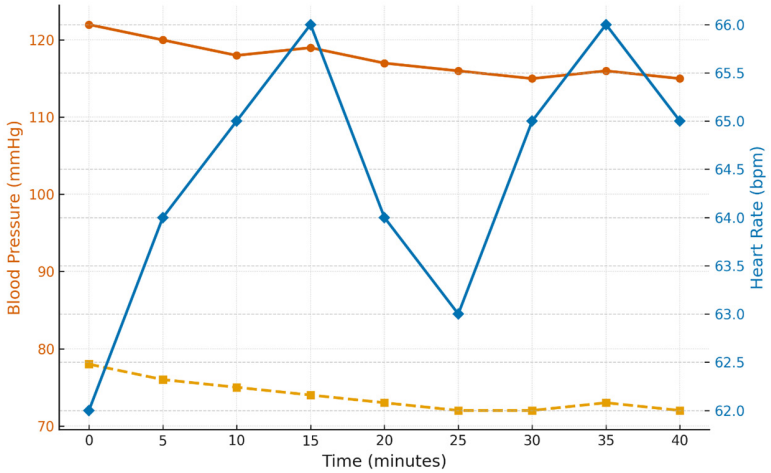

Figure 5. Intraoperative and postoperative monitoring of vital signs during spinal anesthesia. Systolic and diastolic blood pressure, as well as heart rate, remained stable throughout the 40-minute procedure without sedation. The graph shows heart rate (blue line), systolic blood pressure (red line), and diastolic blood pressure (orange line).

the procedure, the patient was transferred to the recovery room. Full recovery of sensory and motor function was confirmed 2 h later, and the patient was moved to the ward. No new neurologic symptoms were observed during the subsequent 2-year follow-up period.

Discussion

The prevalence of Fabry disease in white males is estimated at approximately 0.001% to 0.006%, with classic mutations occurring significantly more frequently in males than in females [3]. Atypical presentations have also been reported to occur 6 to 13 times more often in males than in females [3]. Males typically present with the classic form of Fabry disease during childhood [12], whereas females exhibit a wide spectrum of clinical phenotypes due to random X-chromosome inactivation [6]. Although some female patients are asymptomatic or mildly affected, recent studies have shown that many develop manifestations comparable in severity to those seen in males, including progressive multiorgan involvement [13, 14].

The female patient in the case reported here exhibited extensive involvement of all major organ systems commonly affected in Fabry disease, including the kidneys, heart, nervous system, and eyes, thus falling within the spectrum of the classic Fabry phenotype [15]. Specifically, left ventricular hypertrophy with diastolic dysfunction [16-18], significant proteinuria with an elevated ACR [19-21], ocular features such as cornea verticillata and foveal thinning [22], and polyneuropathy-like symptoms [23] represent key organ-specific indicators consistent with the pathophysiology of Fabry disease (**Table 1**).

Cardiac involvement is a leading cause of morbidity and mortality in Fabry disease. The accumulation of Gb3 within cardiomyocytes contributes to progressive ventricular wall thickening, diastolic dysfunction, and myocardial fibrosis [16]. In the patient described here, transthoracic echocardiography revealed classic features of advanced Fabry disease cardiomyopathy. The IVSd, E/e' ratio, and GLPS were consistent with concentric left ventricular hypertrophy, increased left ventricular filling pressure, and early systolic dysfunction, respectively [17]. Additionally, subendocardial brightness, an echocardiographic finding commonly associated with myocardial fibrosis or glycosphingolipid accumulation in Fabry disease, was observed [18]. These cardiac findings indicate significant functional impairment and underscore the importance of comprehensive preoperative cardiovascular evaluation and individualized anesthetic planning in patients with Fabry disease.

Renal involvement in Fabry disease results from the progressive accumulation of Gb3 and other glycosphingolipids in glomerular cells, peritubular capillaries, vascular endothelium, smooth muscle cells, and distal tubular epithelial cells [19, 20]. This deposition initiates a chronic pathological process that typically begins with persistent proteinuria and may, if untreated, progress to end-stage renal disease [6, 21]. In the case reported here, although the serum creatinine level of the patient was within the normal range, the microalbumin level and ACR were markedly elevated, indicating significant renal involvement. Renal dysfunction may alter the pharmacokinetics and pharmacodynamics of anesthetic agents, particularly those

Table 1. Summary of multiorgan involvement in the patient with Fabry disease

Organ System	Clinical Findings	Diagnostic Results
Renal	Proteinuria	ACR 1011.2 mg/g, Creatinine 78.83 μmol/L
Cardiac	Left ventricular hypertrophy, sinus bradycardia	IVSd 14.3 mm, GLS -11.2%, E/e' 17.2
Neurologic	Paresthesia, subjective symptoms consistent with polyneuropathy	Normal nerve conduction and electromyography studies
Ophthalmologic	Blurred vision, cornea verticillata	OCT: foveal thinning and scar; slit-lamp: keratopathy

*Abbreviations: * ACR = albumin-to-creatinine ratio; IVSd = interventricular septal diameter; GLS = global longitudinal strain; OCT = optical coherence tomography.

eliminated via the kidneys, thereby increasing the risk of drug accumulation and associated toxicity. Consequently, anesthetic planning should incorporate drug selection and individualization of the dose to minimize these risks.

Despite the presence of multiorgan involvement, spinal anesthesia was selected over general anesthesia in this case, and its successful administration is an outcome of particular significance. Compared to general anesthesia, spinal anesthesia has a more limited impact on the cardiovascular and autonomic nervous systems [10, 11], making it a potentially safer alternative in high-risk patients. General anesthesia involves the combined administration of multiple pharmacologic agents and typically induces greater hemodynamic fluctuations than those caused by spinal anesthesia. In Fabry disease, the risk is compounded by cardiac abnormalities such as concentric left ventricular hypertrophy, diastolic dysfunction, and impaired autonomic regulation. These factors increase susceptibility to intraoperative hypotension, arrhythmias, and delayed recovery. Renal dysfunction further complicates the picture by reducing the clearance of anesthetic agents, heightening the risk of drug accumulation and toxicity. Thus, spinal anesthesia was selected in this case to minimize the cardiovascular burden and systemic drug exposure.

The willingness of the patient to undergo spinal anesthesia without sedation also minimized respiratory compromise and enabled effective real-time monitoring. Vital signs remained stable throughout the procedure and no adverse neurologic or cardiovascular outcomes were noted during the 2-year follow-up period. These results support the utility of spinal anesthesia as a viable alternative to general anesthesia in selected patients with Fabry disease and multiorgan dysfunction.

Although general anesthesia remains the predominant approach in patients with Fabry disease, spinal anesthesia should be considered when regional anesthesia is feasible and patients are willing. Spinal anesthesia may be particularly appropriate in areas where regional techniques offer sufficient analgesia and anesthesia coverage, such as the lower abdomen and pelvis, and in orthopedic and urologic surgeries. Furthermore, a case report has documented uneventful spinal anesthesia for cesarean section in a patient with Fabry disease [24]. However, evidence remains extremely limited. As Fabry disease involves systemic manifestations, an individualized risk assessment and interdisciplinary collaboration remain paramount when selecting the most appropriate anesthetic modality.

In conclusion, the findings of this case report suggest that spinal anesthesia is a potential anesthetic strategy in patients with Fabry disease and multiorgan involvement. Despite cardiac, renal, and autonomic dysfunction, spinal anesthesia was successfully administered without complications and resulted in stable hemodynamics and complete neurologic recovery. These results emphasize the importance of individualized anesthetic planning based on comprehensive systemic evaluation and multidisciplinary collaboration. The continued accumulation of clinical experience is essential to establish evidence-based guidelines for anesthetic management in this high-risk population.

Disclosure of conflict of interest

None.

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