Case Report

A First in Literature: Anesthesia Management in Kidney Transplant Surgery of a Patient with McArdle Disease

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Abstract

McArdle disease is an inherited myopathy that autosomal recessive inheritance and is also known as glycogen storage disease type 5. Myoglobinuria, increase in serum CK level and darkening of urine color secondary to myoglobinuria are typical. Patients may have symptoms associated with increased rhabdomyolysis secondary acute renal failure or hyperkalemia after long and strenuous exercise periods. Today, many studies in the literature have shown that transplantation is superior to dialysis in patients with end-stage renal disease. Our case is a 53-year-old male patient with the diagnosis of McArdle syndrome who was going to have a kidney transplant. The patient had essential hypertension and history of HBsAg+. Total intravenous anesthesia technique was chosen as the anesthesia technique because inhaled anesthetic agents may trigger malignant hyperthermia in the patient. We didn't experience any perioperative complications in our patient. In conclusion, renal transplantation performed with total intravenous in a McArdle syndrome patient may be a simple and effective technique.

Keywords: *Anesthesia, kidney transplant, McArdle disease*

Introduction

McArdle disease is an inherited myopathy first described by Brian McArdle in 1951.[1] The disease has autosomal recessive inheritance and is also known as glycogen storage disease type 5. Although the incidence in epidemiological studies in the United States was found to be between 1/50000 and 1/200000, there are also molecular studies in the literature showing that the incidence is much higher than the aforementioned rates.[2,3] The clinical picture of exercise intolerance frequently manifesting with muscle weakness, myalgia, and cramps due to glycogen myophosphorylase enzyme deficiency (PYGM) is a typical feature in patients.[4] Since the breakdown of mitochondrial fatty acids and glucose is impaired due to PYGM enzyme deficiency, amino acids are used as an alternative energy source during exercise, thereby resulting in muscle damage.[5] Since rhabdomyolysis occurs after prolonged exercise, patients often avoid such exercises. The disease has a good prognosis in most patients. Another factor in the good prognosis of the disease is the isolation of the defective PYGM enzyme in skeletal muscle, unlike the isomers in liver and brain. In such cases, the disease progresses with a clinical picture of pure myopathy that involves only the skeletal muscle. Made based on the typical clinical picture, its definitive diagnosis is also made by using genetic methods and by demonstrating the defect in muscle biopsy and myophosphorylase activity and the absence of lactate increase during forearm ischemic exercise test or cycle ergometer test.[6,7]

Myoglobinuria is observed in patients secondary to the increase in the muscle breakdown products creatine kinase (CK) and myoglobin after moderate-to-heavy exercise. An increase in serum CK level and darkening of urine color secondary to myoglobinuria are typical. Although patients may have symptoms associated with increased rhabdomyolysis secondary acute renal failure or hyperkalemia after long and strenuous exercise

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periods, these attacks are rare.[8] Today, effective treatment of the disease has not been found yet, but thanks to the prevention of attacks, most patients can continue their lives with normal survival.

Today, many studies in the literature have shown that transplantation is superior to dialysis in patients with end-stage renal disease.[9-11] For this reason, the number of renal transplantations performed is increasing rapidly day by day. In order to increase the success rates in transplantations, countries develop national transplantation programs and establish multidisciplinary teams. Anesthesiologists are one of the most important parts of the multidisciplinary team in the preparation of patients for surgery during the preoperative period, in patient management during the intraoperative period, and in postoperative follow-up of patients. Patients should be managed correctly in the perioperative period due to various metabolic and systemic pathologies, and comorbidities associated with chronic renal failure. Additionally, to reduce mortality, they should be followed up closely with a perioperative multidisciplinary approach.

There are case reports in the literature on McArdle disease and anesthesia management, which is rarely encountered in daily anesthesia practice.[12,13] We have not encountered however any studies related to McArdle disease and renal transplantation anesthesia. For this reason, we aimed to contribute to the literature with this study, in which we reported our renal transplantation experience in a patient with McArdle disease.

Case

A 57-year-old male patient was diagnosed with McArdle disease at the age of 35. The patient had complaints of pain in the muscles, darkening of the urine color, and fatigue and weakness during exercise. Upon detection of elevated CK in further examinations, muscle biopsy and genetic study was performed on the patient and the patient diagnosed with McArdle disease. McArdle disease was diagnosed in 6 of the patients' relatives based on the results from the genetic analyses and examinations conducted. The patient has been followed up in the nephrology clinic for 6 years; as we have seen in the patient's records, he had complaints of darkening of the urine color and widespread body pain in nearly 50 instances so far. Severe proteinuria was not detected in the patient's follow-ups, but living kidney transplantation from his wife was planned for the patient with a urea level of 175 mg/dl, creatinine of 7.85 mg/dl, and glomerular filtration rate (GFR) of 8.

The patient had a height of 170 cm and a weight of 65 kg and had a history of Hepatitis B and hypertension. Because of the required administration of immunosuppressive therapy (tacrolimus) in the patient who inter alia had Hepatitis B, the endocrinology clinic was consulted and the infectious diseases clinic was consulted. Prophylactic antibiotic therapy was started in order to prevent hospital and surgical site infections. Hemodialysis was applied to the patient 12 hours before the surgery, the dose of immunosuppressive agent was adjusted and the appropriate prophylactic antibiotic was started by the infection clinic.

Prior to conventional hemodialysis, the patient had a urea value of 195 mg/dL, a creatinine value of 7.60 mg/dL, and a ck value of 1440 U/l. According to the patient's history, the patient had severe rhabdomyolysis and myoglobinuria attacks and we, therefore, determined that the patient was Grade 2 in Matinuzzi's clinical grading.[14]

The patient was followed closely for sCK levels due to renal failure and increased myoglobinuria secondary to rhabdomyolysis that may occur after transplantation. Before the surgical procedure, patient consent was obtained and blood tests were run to evaluate the patient in bed. The patient was given detailed information about the procedure to be performed, the disease that he had and the clinical conditions that may develop secondary to malignant hyperthermia, rhabdomyolysis, and myoglobinuria that can be seen in patients with this type of muscle disease. Anesthesia consent was obtained from the patient. The operating room to be operated on was cleaned the day before, the breathing circuits were changed, all agents that could trigger malignant hyperthermia including soda lime were removed. An appropriate dose of dantrolene sodium was prepared. After a fasting period of 6 hours before surgery, the patient was taken to the operating room. After an intravenous route through the antecubital vein was established using 18 gauge branules on the patient, his routine monitoring was performed. The patient was warmed in the operating room with a convectional heating unit in case chills and shivering could increase muscle breakdown. Total intravenous anesthesia technique was chosen as the anesthesia technique because inhaled anesthetic agents may trigger malignant hyperthermia in the patient.

Pre-induction arterial blood pressure value of the patient was 160/86 mmHg, heart rate was 100 beats/min, oxygen saturation value was 96, and end-tidal carbon dioxide value was 30mmHg. The patient was ventilated with 100% oxygen (6-8 lt/min) for 3 minutes through a completely cleaned device for preoxygenation, and 1μg/kg^{-1} fentanyl was administered before intubation.

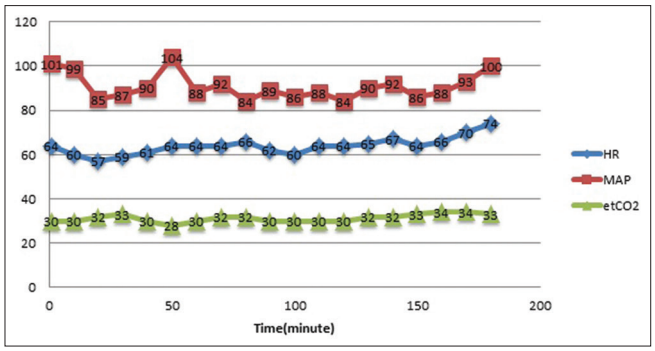

Figure 1: The patient's arterial blood pressure, heart rate, and $etCO_2$ values in the intraoperative period

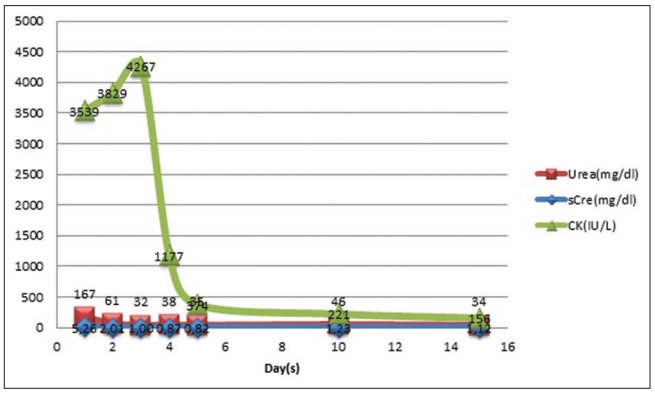

Figure 2: Laboratory parameters

In the induction of anesthesia, 2 mg midazolam and 2.5 mg/kg^{-1} propofol intravenous (iv.) were administered. Subsequent to confirming the termination of spontaneous respiration in the patient; rocuronium 0.5 mg/kg^{-1} iv was administered and endotracheal intubation was provided. Due to the possible need for intraoperative massive transfusion and postoperative hemodialysis, an 11F central venous catheter was inserted in the right internal jugular vein with the help of ultrasonography and a catheter was accessed on the right radial artery for monitoring invasive arterial blood pressure. Propofol infusion and remifentanil infusion were preferred for maintenance of anesthesia. Propofol was administered as 10 mg/kg^{-1} s^{-1} in the first ten minutes, 8 mg/kg^{-1} s^{-1} in the next ten minutes, and finally 5-6 mg/kg^{-1} s^{-1} throughout the surgery, while remifentanil was administered as infusion in 0.5 μg kg^{-1} min^{-1}. During the maintenance, the patient was also given a 50%/50% O_2/air mixture (2.5 liters/minute). The surgical procedure took 180 minutes. The patient was extubated 15 minutes after the end of the procedure was taken to the intensive care unit for close follow-up and monitoring. The patient's arterial blood pressure, heart rate, and $etCO_2$ values in the intraoperative period are shown in Figure 1.

The patient was followed up closely by the multidisciplinary team in the postoperative period. The patient was taken to the ward after 24 hours of intensive care follow-up and kept under daily routine follow-up. The patient was discharged with full recovery after making sure that the patient did not have severe CK elevation in the postoperative period, had sufficient urine output and urea-creatinine values back to normal levels.

Discussion

Since McArdle disease involves isolated skeletal muscle, it has a relatively good prognosis compared to other types of glycogen storage disease. In the vast majority of patients, the typical clinical picture presents weakness, fatigue, muscle pain, and darkening of the urine color after moderate to heavy exercise, and it is usually diagnosed after the first decade.[13] Only 4% of patients can be diagnosed before the age of 10.[15] According to the grading system of Martinuzzi *et al.*,[14] the patient was grade 2 and diagnosed only after the age of 35 despite being grade 2. Most undiagnosed patients are protected from attacks by limiting their exercise capacity, which was the case in this patient.

The most common finding in McArdle disease, which is the most common glycogen storage disease, is asymptomatic elevation of CK, change in urine color and myoglobinuria secondary to rhabdomyolysis.[16] Acute renal failure is a rare clinical feature in McArdle patients.[17] Acute renal failure is often associated with glycolysis disruption in skeletal muscle and rhabdomyolysis secondary to enzyme deficiency. According to the patient's records, we can say that he had about 50 attacks and probably developed acute renal failure secondary to myoglobinuria.

Based on the clinical opinion of nephrology and subject to the consent of the patient's relative, it was decided to schedule preemptive transplantation for the patient whose GFR was 8. In such patients, applications with the risk of triggering rhabdomyolysis should be avoided in the anesthesia method to be selected. For this reason, we minimized the fasting time to 6 hours in our patient. Since the use of cuffs may increase tissue damage, we preferred invasive arterial monitorization for monitoring blood pressure.[18] The patient was warmed with a conventional heater during the surgery to prevent hypothermia.

Another feared complication in muscle diseases such as McArdle disease is malignant hyperthermia, the results of which can be fatal.[12] Preoperative diagnosis can only be made by *in vitro* contracture test on muscle biopsies taken from patients.[19] Since we did not have the opportunity to perform this test in our hospital, we started the surgery by taking the routine precautions recommended and ensuring close follow-up of the

patient. Although malignant hyperthermia, which can be fatal, was not observed in other cases, given the low number of such cases that did not develop hyperthermia, we as a precaution avoided anesthetic agents (especially inhalation anesthetics) that could trigger the disease. We preferred the total intravenous anesthesia method for the patient. We cleaned the patient's room before surgery, changed the circuits and the soda lime, preferred rocuronium, a non-depolarizing agent, as the muscle relaxant, and started the case with dantrolene sodium at a sufficient dose for the treatment of a possible picture of malignant hyperthermia.

Although there are publications in the literature suggesting that 50% dextrose solution should be given to patients at the end of the surgery to prevent respiratory muscle weakness and related respiratory pathologies in the postoperative period, we did not administer additional dextrose support in the postoperative period in our case and we extubated the patient 15 minutes after the end of the surgery.[20] We did not encounter respiratory problems in the patient during the intensive care follow-ups in the postoperative period.

In the follow-up of possible rhabdomyolysis and myoglobinuria-related kidney damage in patients, they should be monitored for serum values of urea and creatinine and level of creatine kinase enzyme. In our patient, the levels of urea, creatinine and CK in the postoperative period until discharge are shown in Figure 2

A serum CK level of 5000-15000 IU/l is a medium risk for acute kidney injury, while a serum CK level of >15000 IU/l is a high risk.[21] During the follow-up of the patient, the CK level was measured as a maximum of 4267 IU/l and the serum enzyme level decreased rapidly in the postoperative period. In addition, there was no problem in the postoperative diuresis of the patient, and there was a gradual decrease in urea-creatinine values [Figure 2].

Conclusion

Our study is a first in the literature as it evaluates renal transplantation anesthesia management in an adult with McArdle disease in the light of the literature, and it is of significant worth that the present study reports the first case in this respect.

It should be known that McArdle disease can cause chronic kidney failure, although it is rare. If patients are not managed correctly with a multidisciplinary approach in the perioperative period, kidney damage may develop due to rhabdomyolysis attacks or the existing damage may deepen. Anesthesiologists should know the disease well and should be well-prepared for complications such as malignant hyperthermia in anesthesia management and what to do to prevent the development of these complications.

Availability of data and materials

Consent was obtained from the patient solely for the purpose of this study and provided to the authors under the ethics applications cited above. As such, the data can only be made available upon re-consenting the patient.

Abbreviations

PYGM: Glycogen myophosphorylase enzyme

CK: Creatine kinase

GFR: Glomerular filtration rate

IV: Intravenous

Contributions

All authors read and approved the final manuscript.

Ethics approval and consent to participate

At our institution, institutional review board approval is not required for a single case report.

Consent for publication

Written informed consent was obtained from the patient's spouse (patient is deceased) for publication of this case report and any accompanying images. A copy of the written consent is available for review by the Editor-in-Chief of this journal.

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Nil.

Conflicts of interest

There are no conflicts of interest.

References

1. McArdle B. Myopathy due to a defect in muscle glycogen breakdown. Clin Sci 1951;10:13-35.
2. Khattak ZE AM. McArdle Disease-StatPearls-NCBI Bookshelf. Available from: https://www.ncbi.nlm.nih.gov/books/NBK560785/?report=reader. [Last accesssed on 2021 May 05].
3. Nogales-Gadea G, Godfrey R, Santalla A, Coll-Cantí J, Pintos-Morell G, Pinós T, *et al*. Genes and exercise intolerance: Insights from McArdle disease. Physiol Genomics 2016;48:93-100.
4. Martín MA, Lucia A, Arenas J, Andreu AL. Glycogen Storage Disease Type V Synonyms: Glycogenosis Type V, GSDV, McArdle Disease, Muscle Glycogen Phosphorylase Deficiency, Myophosphorylase Deficiency, PYGM Deficiency. europepmc.org. Available from: https://europepmc.org/books/n/gene/gsd5/?extid=20301295&src=med. [Last accessed on 2021 May 05].
5. Shamim F, Siraj S, Salim B, Afroze B. Perioperative anesthetic management of children having Inborn errors of metabolism. Saudi J Anaesth 2017;11:120-1.
6. Kubisch C, Wicklein EM, JentschTJ. Molecular diagnosis

of McArdle disease: Revised genomic structure of the myophosphorylase gene and identification of a novel mutation. Hum Mutat 1998;12:27-32.
7. Vissing J, Haller RG. A diagnostic cycle test for McArdle's disease. Ann Neurol 2003;54:539-42.
8. Lucia A, Ruiz JR, Santalla A, Nogales-Gadea G, Rubio JC, García-Consuegra I, *et al*. Genotypic and phenotypic features of McArdle disease: Insights from the Spanish national registry. J Neurol Neurosurg Psychiatry 2012;83:322-8
9. O'Connell PJ, Brown M, Chan TM, Claure-Del Granado R, Davies SJ, Eiam-Ong S, *et al*. The role of kidney transplantation as a component of integrated care for chronic kidney disease. Kidney Int Suppl 2020;10:e78-85.
10. Rivera D, Tejada JH, Medina A, Martínez LE, Nieto NM. Anesthesia complications in renal transplantation. Rev Colom Anestesiol 2011;39:30-7.
11. Rang ST, West NL, Howard J, Cousins J. Anaesthesia for Chronic renal disease and renal transplantation. EAU-EBU Updat Ser 2006;4:246-56.
12. Bollig G, Mohr S, Ræder J. McArdle's disease and anaesthesia: Case reports. Review of potential problems and association with malignant hyperthermia. Acta Anaesthesiol Scand 2005;49:1077-83.
13. Yeoh C, Teng H, Jackson J, Hingula L, Irie T, Legler A, *et al*. Metabolic disorders and anesthesia. Curr Anesthesiol Rep 2019;9:340-59.
14. Martinuzzi A, Sartori E, Fanin M, Nascimbeni A, Valente L, Angelini C, *et al*. Phenotype modulators in myophosphorylase deficiency. Ann Neurol 2003;53:497-502.
15. DiMauro, S. Nonlysosomal glycogenoses. Myology, 1994;P:1554.
16. RubioJC, Lucia A, Fernández-Cadenas I, Cabello A, Blázquez A, Gámez J, *et al*. Novel mutation in the PYGM gene resulting in McArdle disease. Arch Neurol 2006;63:1782-4.
17. Simpson JP, Taylor A, Sudhan N, Menon DK, Lavinio A. Rhabdomyolysis and acute kidney injury. Eur J Anaesthesiol 2016;33:906-12.
18. Bollig G. McArdle's disease (glycogen storage disease type V) and anesthesia-A case report and review of the literature. Paediatr Anaesth 2013;23:817-23.
19. Ørding H, Brancadoro V, Cozzolino S, Ellis FR, Glauber V, Gonano EF, *et al*. *In vitro* contracture test for diagnosis of malignant hyperthermia following the protocol of the European MH group: Results of testing patients surviving fulminant MH and unrelated low-risk subjects. Acta Anaesthesiol Scand 1997;41:955-66.
20. Brown BR Jr, Walson PD, Taussig LM. Congenital metabolic diseases of pediatric patients: Anesthetic implications. Anesthesiology 1975;43:197-209.
21. Zutt R, van der Kooi AJ, Linthorst GE, Wanders RJ, de Visser M. Rhabdomyolysis: Review of the literature. Neuromuscul Disord 2014;24:651-9.