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Case Report

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The Early Detection of Perirenal Extravasation of Irrigation Fluids Used in Intrarenal Surgery via Near Infrared Spectroscopy Monitorization: Case report

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ABSTRACT

Retrograde intrarenal surgery has become the primary approach for the treatment of renal stones among many centers. The excessive use of irrigation fluids during procedures may cause an increase in intrarenal pressure; hence leading to their perirenal extravasation. This case report aims to emphasize the significant steps of anesthesia management of a 4.5 year old male pediatric patient who, despite achieving adequate depth of anesthesia while undergoing intrarenal surgery due to cystine stones, was reported to have tachycardia, hypertension, increased lung pressure and a significant decrease in his right kidney regional oxygen saturation index measured by near infrared spectroscopy.

Key Words: Near infrared spectroscopy, Renal blood flow, Surgery, Pediatrics, Anesthesiology

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Introduction

Near infrared spectroscopy (NIRS), is a method used to measure regional tissue oxygenation by sending infrared light to tissues and interpreting the reflecting oxyhemoglobin and deoksihemoglobin signals. NIRS enables saturation measurement for tissue depth of up to 2-3 cm. This feature, along with the use of an appropriate sized probe, makes the pediatric population an ideal study group for monitoring renal oxygenation [(1)].

Regional oxygen saturation (rSO2) shows the balance between tissue oxygen demand and oxygenation while also reflecting the microcirculation of arterial, venous and capillary blood vessels. Therefore, NIRS is an important instrument for detecting subclinic hypoperfusion (microcirculation dysfunction) NIRS offers a non-invasive and continuous means to monitor regional tissue oxygen saturation (rSO2), making it an attractive modality in anesthesia practice [(2)]. NIRS monitorization may be effective in predicting and managing the negative renal outcomes caused by ureterorenoscopy initiated intrarenal pressure due to its ability to display renal oxygenation in pediatric cases. This report aims to present the anesthesia management of a RIRS case in which NIRS was used to evaluate the effect that increased intrarenal pressure caused by the perirenal extravasation of irrigation fluids had on renal oxygenation.

CASE

A 4.5 year old, 11 kg male patient with a Staghorn cystine stone located in his right kidney was preoperatively evaluated for RIRS (Retrograde Intrarenal Surgery) and an informed consent was obtained. Medical history taking from the patients family revealed a previous diagnosis of hypotonia-cystinuria syndrome. Preoperative physical examination and laboratory evaluations were considered normal. Preoperative ultrasonography (USG) showed multiple, calyceal and pelvis filling, 12 mm diameter stones in the middle and lower sections of the right kidney. Premedication was administered via 0.1 mg/kg intravenous (IV) midazolam 15 minutes before the patient was transferred to the operating room. Bilateral NIRS monitorization was administered to the patient in order to evaluate heart rate (HR), non-invasive systolic blood pressure (SBP), diastolic blood pressure (DBP), peripheral oxygen saturation (SpO2) and renal perfusion (Figure 1).

Anesthesia induction was carried out via IV 2 mg/kg propofol, 1 mcg/kg fentanyl, 0.5 mg/kg lidocaine, 0.5 mg/kg rocuronium bromide and followed by endotracheal intubation with a 5.0 cuff size endotracheal tube. Anesthesia maintenance was obtained via 50% oxygen/50% air, 2-4% sevoflurane (MAC 1-1.3) and remifentanil 0.05-0.2 mcg/kg/min with 3 L/min fresh gas. The patient was put in lithotomy position. Intraoperative gravity irrigation was performed with 3L normal saline via a manual pump after placing the bottom of the irrigation bag 50 cm above the patient's symphysis pubis. A ureteral access sheath (UAS) was used while performing RIRS. IV 1/3 Isodex was administered at 50 mL/h during the total 120 minutes of anesthesia monitorization. Despite achieving adequate depth of anesthesia the patient showed tachycardia and hypertension 40 minutes into the operation. This was soon followed by an increase in pulmonary pressure and a 75th minute decrease in the right kidney NIRS (Figure 2).

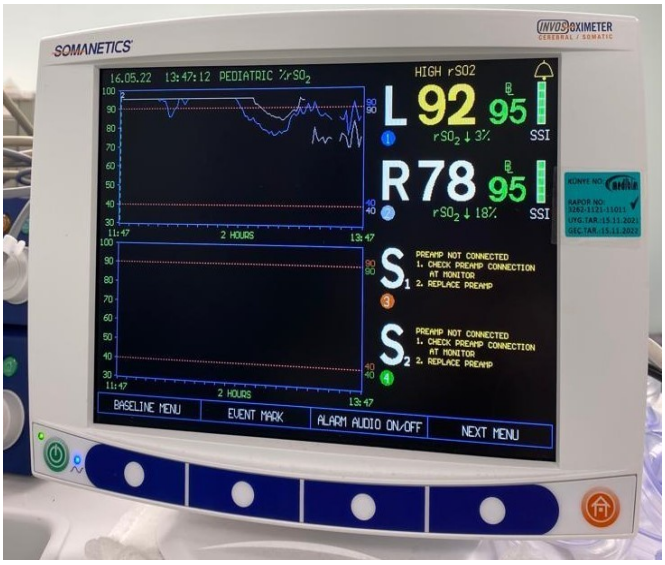

Figure 1. NIRS monitor

Generalized hard distension was palpated upon abdominal examination. Right basal breath sounds were found to be diminished however there were no signs of rales or rhonchi. The surgical team were given notice

and the operation was ceased at the 80th minute. A total of 9000 cc irrigation fluid was administered to the patient throughout the whole operation. An intraoperative abdominal USG was performed at the 105th minute by the interventional radiologist upon suspicion of perirenal extravasation. Intraperitoneal free fluid was reported and an intraperitoneal drainage catheter was placed.

A total of 500 cc serous fluid was drained. Upon this procedure pulmonary pressure, SBP and DBP decreased while NIRS increased (Figure 2). Anesthesia was discontinued and the patient emerged. Following spontaneous ventilation and normal response to verbal stimuli, the patient was then transferred to the pediatric surgery intensive care unit (ICU) for close postoperative monitorization. All blood samples collected during the patients ICU stay were considered within normal range except for elevated white blood cells (20.020 mcL). Arterial blood gas was as follows: pH: 7.27, pO2: 64, pCO2: 33, HCO3: 15, base excess: -10.6. A postoperative 1st hour PA chest x-ray showed right side pleural effusion and a tube thoracostomy was performed. NIRS monitorization continued for 8 hours in the ICU in order

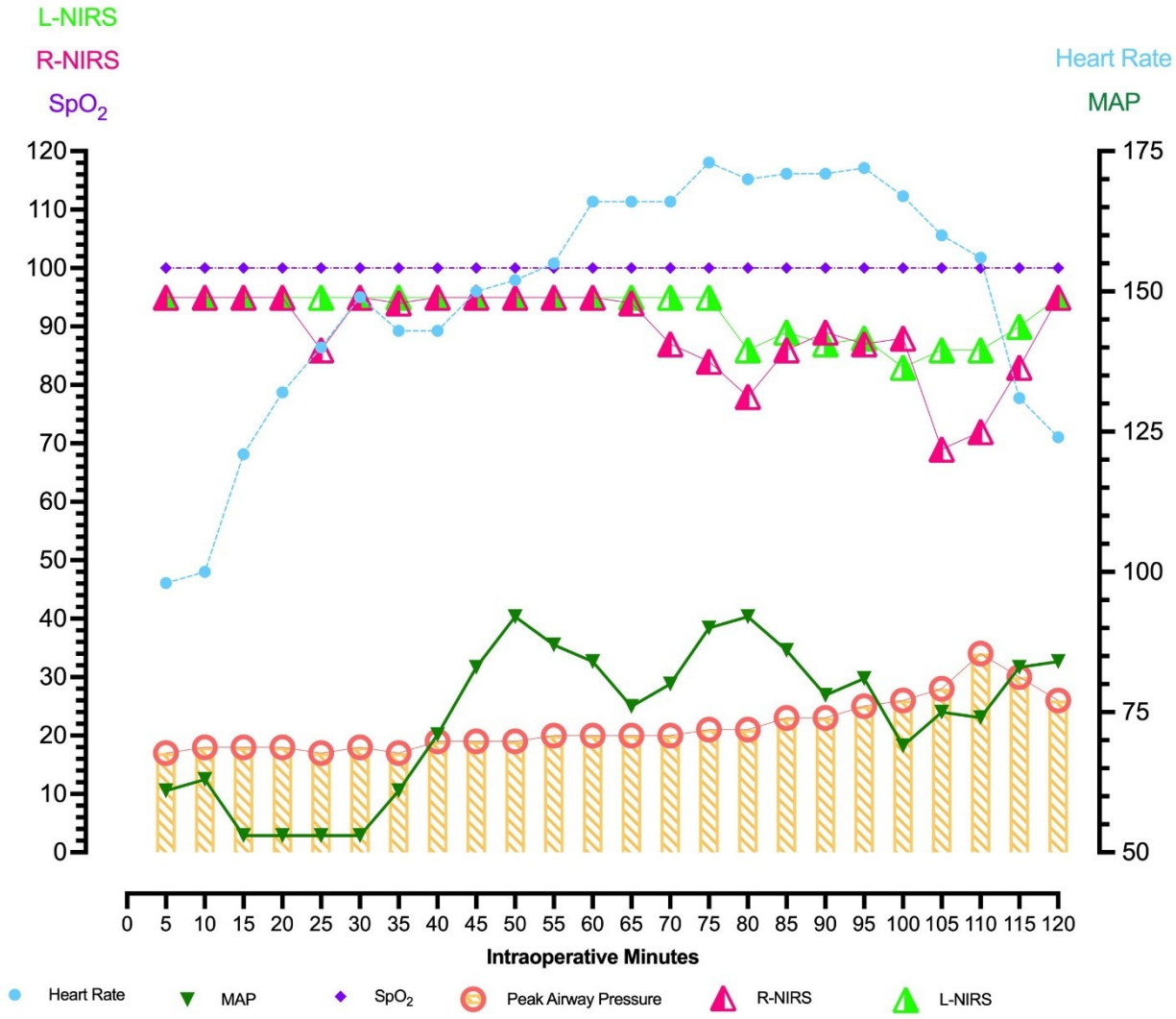

Figure 2. NIRS monitorization. Heart rate, non-invasive systolic blood pressure, diastolic blood pressure, peripheral oxygen saturation and renal perfusion values.

to observe renal perfusion. Bilateral NIRS values returned to normal within the 1st postoperative hour. Intraoperative extravasation resolved without sequelae within the first postoperative day (Figure 2).

Discussion

NIRS, is a non-invasive method used for monitoring oxygenation. It is beneficial in the early detection of decreased saturation and complications affecting various visseral tissues. Studies have shown that intraoperative NIRS can be used not only for cerebral imaging but also for the evaluation of renal blood flow and prediction of renal pathologies and damage [3-5]. The use of NIRS monitorization as a reflection of renal oxygenation may be beneficial for the prediction of negative renal effects caused by ureterorenoscopy and planning of necessary management. We, too, have determined the effects increased intraabdominal pressure due to the excessive use of irrigation fluids, and perirenal extravasation from prolonged RIRS operations, has on renal oxygenation via the use of NIRS and hemodynamic monitorization.

Renal oxygenation studies using NIRS are based on values below normal range. Previous studies show a cut-off rSO2 value for renal oxygenation of %65. Values below this level indicate renal hypoxia. In addition to this, there are also studies that determined decreases greater that 25% are indicative renal hypoxia [5].

In addition, other studies have also found that 10-20% decreases in renal oxygenation to be significant [6]. Our case showed a decrease greater than 20% at the 105th minute and was considered significant according to literature.

Ureterorenoscopy is a method of imaging used to evaluate the ureter and renal pelvis and help guide treatment. A closed pelvicalyceal system and the manual use of excessive irrigation fluids causes an increase in intrarenal pressure. Despite being normally limited to 10 mmHg (13 cmH2O), intrarenal pressure may rise to as high as 400 mmHg during such endoscopic procedures. Increased intrarenal pressure may lead to renal forniceal rupture and the perirenal extravasation of irrigation fluids [7]. Increased intrarenal pressure has been associated with pyelovenous, pyelolymphatic and pyelotubular backflow of irrigation fluids, forniceal rupture and renal tissue damage [8]. Ureterorenoscopy may result in the transmission of urine between renal fornyx and renal veins, known as the pyelovenous backflow phenomenon. Intrarenal pressure exceeding 20-40 mmHg has been shown to cause pyelovenous backflow [9].

A ureteropylescopic study by Schwalb et al. on pigs determined that intrarenal pressure may reach 439 mmHg [10].

Systemic fluid absorption was first discovered by Hahn et al. in a patient undergoing transurethral prostate resection with spinal anesthesia by mixing ethanol with irrigation fluids and measuring the absorbed ethanol levels via breath alchohol testing [11].

A ureteroscopic study by Rehman et al. on pigs aiming to determine the relationship between increased intreranal pressure and parenchymal fluid extravasation used a mixture of ink and irrigation fluids. Histological evaluation showed a correlation between tissue penetration, the amount of irrigation fluid used and intrarenal pressure [12].

A study by Kukreja et al. focusing on fluid absorption during percutaneous nephrolithotomy (PCNL) determined that using irrigation fluid greater than 9 litres increased fluid absorption. The reported the amount of extravasation was recorded as 44-474 mL. Some patients were reported to have developed intraoperative renal subcapsular hematomas and pelvicalyceal wall perforation [13]. The results of such studies have lead us to conclude that the formation of free intraperitoneal fluid, as in our case, was caused by the perirenal extravasation of irrigation fluids.

Intraperitoneal fluids increase intraabdominal pressure (IAP) and alter hemodynamic stability. IAP greater than 12-15 mmHg causes a decrease in renal perfusion. Increased IAP has also been reported to increase heart rate, mean blood pressure, systemic and pulmoner vascular resistance as aresult of decreasing preload, cardiac output and venous return [14]. This explains the tachycardia, elevated blood pressure and peak inspiratory pressure observed in our case. Pulmonary pressure may also increase due to transdiaphragmatic transmission of increased IAP.

Many studies have shown that increased IAP leads to decreased cortical and medullar perfusion; resulting in a decreased glomerular filtration rate, creatinine clearance and urine output [(2)]. NIRS values for our case returned to normal range at the early postoperative stage, especially after the drainage of intraperitoneal fluid.

This supports the idea that decreased renal blood flow causes insufficient oxygenation.

Results

Based on our respective case, it can be said that endoscopic urologic surgery may have negative effects due to increased intrarenal pressure. Further research is necessary to elucidate the relationship between fluid absorption and pyelovenous and pyelolymphatic backflow. Renal NIRS may assist with the early detection of hemodynamic deteroriation and help predict renal damage. This may be especially useful for renal perfusion monitorization of patients with renal pathologies and solitary kidneys. A NIRS monitorization protocol may be designed and administered for perioperative patients with high renal risk. Precautions aimed to decrease intrarenal pressure such as the use of ureteral access sheaths (UAS), reasonable manual intraoperative irrigation and the application of postoperative double-J stenting may significantly contribute to lower the risk of perirenal extravasation.

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There is no financial support and sponsorship.

Conflict of Interest

We have read the current journal and will comply with the instructions and accept the conditions set down therein. It has been prepared according to each and every one of the manuscript rules. All the named authors have seen and agreed to the submitted version of a paper. There are no prior publications with any overlapping information, including studies and patients. We have no conflicts of interest to declare.

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