

Acute Kidney Injury Subsequent to Hemolysis Following Pulsed-Field Ablation of Atrial Fibrillation

Andrea Natale*, Sanghamitra Mohanty

Department of Cardiology, Texas Cardiac Arrhythmia Institute, Texas, USA

ABSTRACT

Based on the findings from prior experimental studies and few recent reports in human patients, hemolysis and subsequent Acute Kidney Injury (AKI) are potential complications of delivery of high-voltage pulses in Pulsed-Field Ablation (PFA). Even though the risk and severity of hemolysis has been demonstrated to be determined by the number of applications, the safety threshold of the same is not clearly delineated yet. However, based on our experience, the risk of AKI can be mitigated by planned peri-procedural hydration therapy and close monitoring of the functional status of the kidneys in the immediate post-procedure period. Large studies are warranted to define the safety limit of the extent of applications and the best therapeutic approach to reduce the risk of AKI to the minimum, when higher number of applications are needed to treat the arrhythmia.

Keywords: Pulsed-field ablation; Acute kidney injury; Hemolysis; Haptoglobin; Serum-creatinine

DESCRIPTION

Pulsed-Field Ablation (PFA), a newly introduced non-thermal approach for the management of Atrial Fibrillation (AF) is rapidly emerging as the technology with many promises such as tissue-selectivity, ability to create durable lesions and high safety profile. However, the high voltage pulses can potentially cause hemolysis, as shown by earlier experimental studies [1,2]. Exposure to free-hemoglobin released from the lysed red blood cells could subsequently cause adverse clinical outcomes such as Acute Kidney Injury (AKI) [3]. Under physiologic conditions, free-hemoglobin gets bound to the scavenger protein, Haptoglobin and the complex gets cleared by spleen and liver macrophages. However, extra hemolysis can cause saturation of this scavenger system leading to extra burden on the glomerular filtration and AKI [3]. Very few studies have reported about this newly recognized complication of PFA.

Venier, et al., had two cases of AKI post-PFA occurred in mid-2023, following which they evaluated 68 consecutive patients undergoing PFA procedure [4]. Significantly depleted Haptoglobin (marker of hemolysis) level (<0.04 g/L) was detected in 19 of the 68 (28%) patients. Median number of PFA applications in the overall population was 64 (54; 76). Total number of applications was significantly higher in the 19

patients experiencing hemolysis vs. the no-hemolysis group (median number of applications: 75 vs. 62, $p=0.011$). More than 70 applications was shown to have better sensitivity and specificity to predict haemolysis. The study reported a significant inverse correlation between the number of applications and the plasma level of Haptoglobin.

We evaluated the occurrence of hemoglobinuria after PFA and its impact on renal function in consecutive AF patients from multiple centers [5]. All underwent isolation of Pulmonary Veins (PV) and ablation of additional structures such as left atrial posterior wall and other non-PV foci, as needed.

Our main findings were the following: 1) 21 (75%) patients undergoing PFA without periprocedural-hydration experienced hemoglobinuria with increase in serum Creatinine (s-Cr) and decrease in haptoglobin in blood, 2) 4 of these 21 patients that received a mean of 94 applications developed oliguria and the s-Cr was elevated ≥ 3 times than their mean baseline value, meeting the diagnostic criteria for AKI III, 3) no increase in s-Cr was noticed in the 75 patients that received hydration therapy following a mean of 59.28 ± 22.49 PFA applications (4 patients got >90 applications) and 4) hydration and number of applications were independent predictors of AKI following PFA. Our study was the first to demonstrate that simple steps such as

Correspondence to: Andrea Natale, Department of Cardiology, Texas Cardiac Arrhythmia Institute, Texas, USA, E-mail: dr.natale@gmail.com

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planned peri-procedural hydration can prevent an impending AKI in patients undergoing extensive ablation.

In a recent article posted in the medRxiv public domain, Osmancik et al., analyzed hemolysis in consecutive patients undergoing Pulmonary Vein Isolation (PVI) with PFA or Radiofrequency Ablation (RFA) [6]. The markers of hemolysis were significantly increased with PFA compared to RFA. Moreover, hemolysis was higher in patients receiving PVI + additional ablation than PVI-only (the extent of hemolysis was dependent on the number of PF applications). This study has neither reported the safety threshold for PF applications nor provided any management strategy to prevent AKI.

CONCLUSION

Hemolysis to some degree seems to be an obvious consequence of PFA with the number of applications determining its severity. Efficacy and safety of therapeutic strategies that target cell-free hemoglobin are not established yet, in clinical settings. Greater understanding of the risk factors that increase vulnerability for hemolysis and delineation of safety thresholds for number of PF applications will likely reveal more targeted approaches in the future, for prevention of this imminent complication. Until then, the simple strategy of peri-procedural hydration therapy should be adopted in all patients receiving AF ablation beyond PVI. In addition to avoiding hypotension during general

anesthesia and maintaining an optimal blood pressure during the procedure.

REFERENCES

1. Aycock KN, Davalos RV. Irreversible electroporation: Background, theory, and review of recent developments in clinical oncology. *Bioelectricity*. 2019;1(4):214-234.
2. Kinoshita K Jr, Tsong TT. Hemolysis of human erythrocytes by transient electric field. *Proc Natl Acad Sci U S A*. 1977;74(5):1923-1927.
3. Deuel JW, Schaer CA, Boretti FS, Opitz L, Garcia-Rubio I, Baek JH, et al. Hemoglobinuria-related acute kidney injury is driven by intrarenal oxidative reactions triggering a heme toxicity response. *Cell Death Dis*. 2016;7(1):2064.
4. Venier S, Vaxelaire N, Jacon P, Carabelli A, Desbiolles A, Garban F, et al. Severe acute kidney injury related to haemolysis after pulsed field ablation for atrial fibrillation. *Europace*. 2024;26(1):371.
5. Mohanty S, Casella M, Compagnucci P, Torlapati PG, Della Rocca DG, La Fazia VM, et al. Acute kidney injury resulting from hemoglobinuria after pulsed-field ablation in atrial fibrillation: Is it preventable? *JACC Clin Electrophysiol*. 2024:S2405-500X(23)00959.
6. Osmancik P, Bacova B, Herman D, Hozman M, Fiserova I, Hassouna S, et al. Peri-procedural intravascular hemolysis during atrial fibrillation ablation: A comparison of pulsed-field with radiofrequency ablation. *medRxiv*. 2024:2024-2102.