

Advanced MRI technique unleashes new approach for diagnosing diabetic kidney disease

June 13 2023

A



B



(A) 9.4-T vertical standard-bore super-conducting magnet, (B) The ^1H and ^{23}Na

surface coil. Credit: *Kidney360* (2023). DOI: 10.34067/KID.0000000000000072

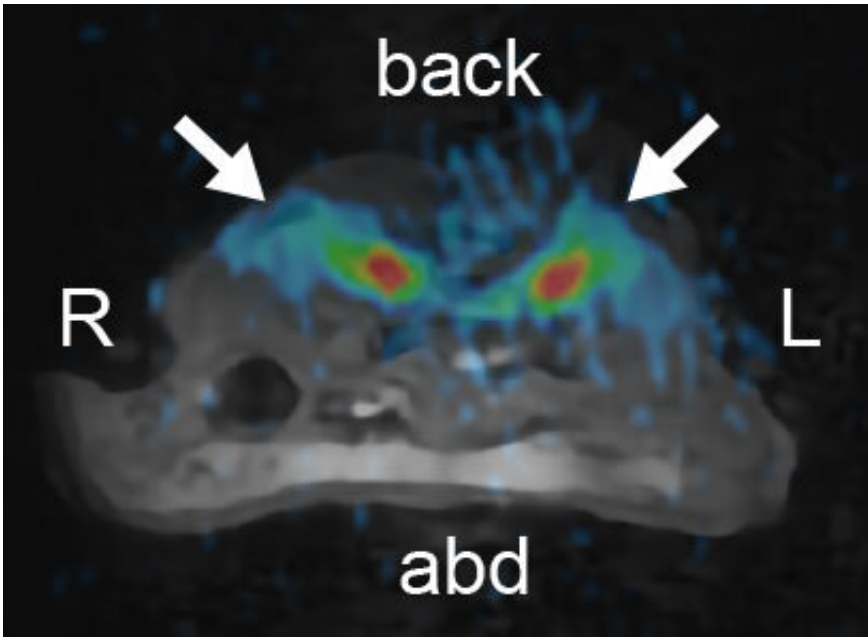
The gold standard test for predicting the onset of diabetic kidney disease is the albuminuria test. However, detecting albuminuria alone has limited sensitivity and specificity in end-stage renal failure with a decreased estimated glomerular filtration rate. This is supported by several reports, which state that about half of the type 2 diabetes patients who developed kidney dysfunction showed no preceding albuminuria.

In this study, the authors propose the possibility of diagnosing tubular abnormalities in diabetic kidney disease at an early stage and connecting them to treatment by combining the evaluation of sodium concentration using ^{23}Na MRI with the measurement of urinary albumin, commonly used in diabetic testing.

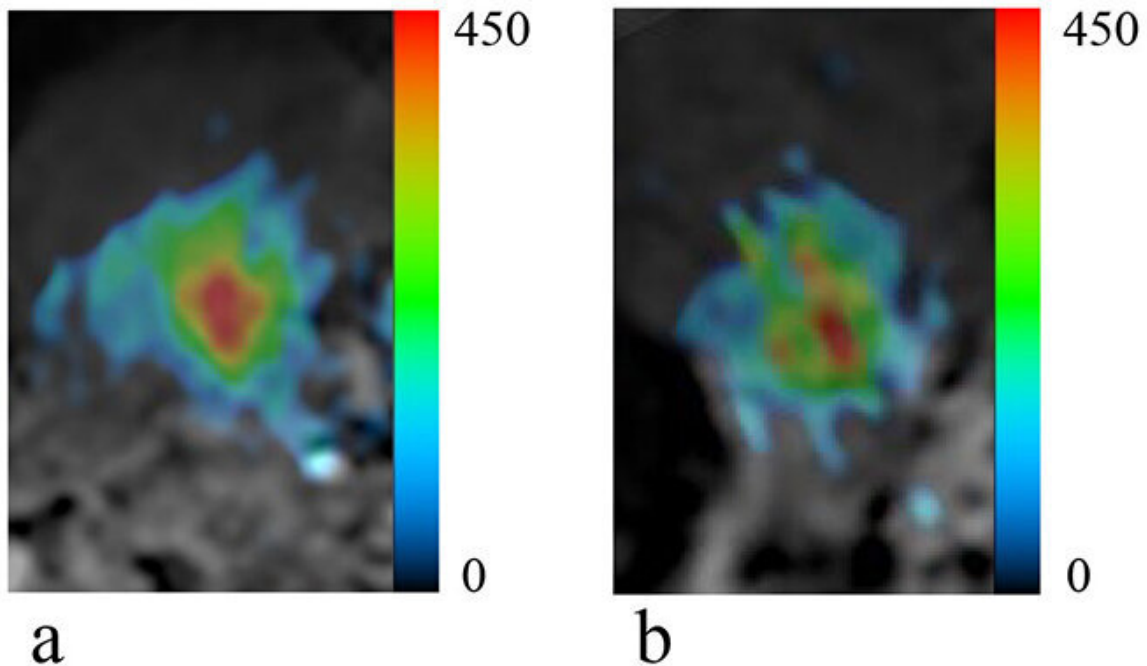
^{23}Na MRI, which images ^{23}Na instead of the clinically applied ^1H in existing MRI, visualizes [metabolic changes](#) in sodium. Although there have been previous reports of ^{23}Na MRI studies, capturing sodium concentrations equivalent to physiological saline and visualizing them clearly in MRI has been challenging because the amount of sodium in vivo is much smaller than hydrogen, resulting in extremely small signal values. This study optimized the newly developed ^{23}Na MRI to image the kidneys of mice, enabling detailed and clear imaging.

The kidney is involved in the excretion and reabsorption of sodium. It is equipped with mechanisms such as the countercurrent multiplication system, which allows efficient water reabsorption, and the formation of an osmotic gradient by [sodium ions](#) from the cortex to the medulla. Although many studies have been conducted on channels and transporters involved in renal sodium metabolism, the changes in kidney's overall amount and distribution of sodium need to be explored

further. The advanced ^{23}Na MRI technique can noninvasively evaluate the distribution of sodium throughout the kidney and assess changes in the countercurrent multiplication system.



^{23}Na MR images merged with ^1H MR images (C57BL/6J mice, 6 weeks old, male). This image shows the transverse plane through the abdomen. Arrows indicate the kidneys. MR, magnetic resonance; ^{23}Na , sodium; ^1H , proton; L, left; R, right; abd, abdomen Credit: *Kidney360* DOI: 10.34067/KID.0000000000000072



Gradient of the signal intensity

(A, B) ^{23}Na MR image merged with ^1H MR image of the right kidney in an m+/m+ mouse (A) and a db/db mouse (B). (C) The signal intensity gradients from the cortex to the medulla in m+/m+ and db/db mice. The signal intensity of the medullary region in the kidney was lower in db/db mice than in m+/m+ mice. The sodium concentration gradients from the medulla to the cortex of m+/m+ and db/db mice were 2.28 ± 0.21 and 1.64 ± 0.36 , respectively (P Kidney360 DOI: 10.34067/KID.0000000000000072

This study used six-week-old diabetic model mice (db/db mice) at an early stage when no [tissue damage](#) was observed in the kidneys and imaged the kidneys using a 9.4 Tesla vertical magnet MRI device optimized by the research group. Compared to control mice, the

formation of the countercurrent multiplication system in the kidney was weakened, as revealed by the ^{23}Na -visualization images. The success of this study is attributed to the research group's invention of the advanced MRI device and their unique imaging techniques.

^{23}Na MRI can reveal metabolic changes in renal sodium and may enable a better understanding of the pathophysiology of not only [diabetic kidney disease](#) but also dehydration and some forms of hypertension related to [sodium](#) metabolism. In the future, the researchers plan to investigate whether these findings can help diagnose other diseases. Moreover, the successful detailed visualization of the mouse kidneys suggests the possibility of expanding the target organs. Accumulating these findings may open new avenues for the clinical application of ^{23}Na MRI.

The article "Sodium [magnetic resonance](#) imaging shows impairment of the countercurrent multiplication system in diabetic mice kidney" was published in the journal *Kidney360*.

More information: Yusuke Nakagawa et al, Sodium Magnetic Resonance Imaging Shows Impairment of the Counter-current Multiplication System in Diabetic Mice Kidney, *Kidney360* (2023). [DOI: 10.34067/KID.0000000000000072](https://doi.org/10.34067/KID.0000000000000072)

Provided by Niigata University

Citation: Advanced MRI technique unleashes new approach for diagnosing diabetic kidney disease (2023, June 13) retrieved 2 May 2024 from <https://medicalxpress.com/news/2023-06-advanced-mri-technique-unleashes-approach.html>

This document is subject to copyright. Apart from any fair dealing for the purpose of private

study or research, no part may be reproduced without the written permission. The content is provided for information purposes only.