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Original Investigation

Association of Unilateral Renal Agenesis With Adverse Outcomes in Pregnancy: A Matched Cohort Study

Jessica Kendrick, MD, MPH,[1,2] John Holmen, PhD,[3] Zhiying You, MD, PhD,[1] Gerard Smits, PhD,[1] and Michel Chonchol, MD[1]

Background: Data regarding the effect of a solitary kidney during pregnancy have come from studies of living kidney donors. We evaluated the risk for adverse pregnancy outcomes in women with a single kidney from renal agenesis.

Study Design: Matched cohort study.

Setting & Participants: Using data from 7,079 childbirths from an integrated health care delivery system from 1996 through 2015, we identified births from women with renal agenesis. Only first pregnancies and singleton births were included. After excluding those with diabetes and kidney disease, 200 women with renal agenesis were matched 1:4 by age (within 2 years), race, and history of hypertension to women with 2 kidneys.

Predictor: Renal agenesis defined by *International Classification of Diseases, Ninth Revision* (*ICD-9*) codes prior to pregnancy.

Outcomes: The primary outcome was adverse maternal outcomes, including preterm delivery, delivery by cesarean section, preeclampsia/eclampsia, and hospital length of stay. Adverse neonatal end points were considered as a secondary outcome and included low birth weight (<2,500 g) and infant death/transfer to acute inpatient facility.

Results: Mean gestational age at delivery was 37.9 ± 2.1 weeks for women with renal agenesis compared to 38.6 ± 1.8 weeks for women with 2 kidneys. Compared with women with 2 kidneys, those with renal agenesis had increased risk for preterm delivery (OR, 2.88; 95% CI, 1.86-4.45), delivery by cesarean section (OR, 2.11; 95% CI, 1.49-2.99), preeclampsia/eclampsia (OR, 2.41; 95% CI, 1.23-4.72), and length of stay longer than 3 days (OR, 1.81; 95% CI, 1.18-2.78). Renal agenesis was not significantly associated with increased risk for infant death/transfer to acute facility (OR, 2.60; 95% CI, 0.57-11.89) or low birth weight after accounting for preterm delivery (OR, 2.11; 95% CI, 0.76-5.88).

Limitations: Renal agenesis was identified by *ICD-9* code, not by imaging of the abdomen.

Conclusion: Women with unilateral renal agenesis have a higher risk for adverse outcomes in pregnancy.
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INDEX WORDS: Solitary kidney; unilateral renal agenesis; pregnancy; adverse maternal outcome; preterm delivery; gestational age; low birth weight; adverse neonatal outcome; cesarean delivery; preeclampsia; eclampsia; hospital length of stay; pregnancy complications.

Chronic kidney disease (CKD) is a worldwide public health problem. It is estimated that the prevalence of CKD is ~3% in women of childbearing age[1]; however, the presence of kidney disease is often underappreciated in pregnancy. CKD during pregnancy is associated with increased risk for adverse maternal and neonatal outcomes. Recently, it has been shown that adverse outcomes occur even with only mild kidney damage and normal glomerular filtration rate (GFR).[1-4]

Women with a solitary kidney may be at high risk for adverse pregnancy outcomes. Data regarding the effect of a solitary kidney during pregnancy have come from studies of living kidney donors and kidney transplant recipients. Studies have found that maternal and neonatal outcomes in living donors are about equal to those of the general population.[5,6] However, there is increased risk for gestational hypertension or preeclampsia in kidney donors than in matched nondonors.[5]

The risk for complications in women with a solitary kidney from causes other than kidney donation may be different. There are important differences between long-term renal outcomes of individuals with congenital solitary kidney and those of healthy adult kidney donors.[7] Hence, despite normal kidney function, there may be subclinical defects of the congenital solitary kidney, which may lead to adverse outcomes. Using data from an integrated health care delivery system, we tested the hypothesis that women

From the [1]Division of Renal Diseases and Hypertension, University of Colorado Denver, Aurora; [2]Denver Health Medical Center, Denver, CO; and [3]Intermountain Healthcare, Salt Lake City, UT.

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Address correspondence to Jessica Kendrick, MD, MPH, Division of Renal Diseases and Hypertension, University of Colorado Denver, Denver Health Medical Center, 660 Bannock St, Mail Code 4000, Denver, CO 80204. E-mail: jessica.kendrick@ucdenver.edu

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with a single kidney from renal agenesis have a higher risk for pregnancy complications compared with women with 2 functional kidneys.

METHODS

Study Design

Using data from the Intermountain Healthcare Enterprise Data Warehouse, which incorporates comprehensive electronic health and administrative data, we conducted a matched cohort study of female patients hospitalized for childbirth between 1996 and 2015. Intermountain Healthcare is a nonprofit organization serving the states of Utah and Idaho. Its facilities range from adult tertiary-level care centers to small rural clinics and hospitals, and it averages 130,000 admissions annually.[8] The Administrative Casemix (*International Classification of Diseases* [*ICD*] codes) database has been used at Intermountain Healthcare for years for research population selection and quality improvement processes. *ICD* coding is entered by the Health Information Management Department. This department has several steps of data validation. The corrected data then interface to populate the Administrative Casemix database, which resides in the Enterprise Data Warehouse.

This project was reviewed by the Intermountain Healthcare Institutional Review Board, protocol #1040486, and was determined to be exempt from the federal rules governing human subjects research and informed consent was not required.

Study Population

We included all female patients hospitalized for childbirth who had clinical and administrative data available in the Intermountain Healthcare system. We included all mother-infant pairs from singleton live births to primiparous women (Fig 1). Women with unilateral renal agenesis were identified by the *ICD, Ninth Revision* (*ICD-9*) code for renal agenesis (753.0). All women had a diagnosis of renal agenesis prior to pregnancy. Women with only one kidney due to kidney donation (n = 75), those with a history of CKD (n = 33), those with a history of diabetes (n = 14), and those with multiple gestation (n = 65) were excluded from the analysis. A woman was considered to have CKD if a Charlson *ICD-9* code for kidney disease (582.x, 583-583.7, 585.x, 586.x, and 588.x)[9] existed prior to pregnancy or in the first trimester and/or if an *ICD-9* code for proteinuria (791)[9] existed prior to pregnancy.[10] We identified 205 women with renal agenesis and normal kidney function. We performed a random chart review of 87 women included in this cohort to confirm the diagnosis of renal agenesis. Of the 37 patients with an *ICD-9* code for renal agenesis, on chart review, we found that all had documentation of a single/solitary/absent kidney. Of the 50 patients who did not have an *ICD-9* code for renal agenesis, we found that 2 patients had physician documentation of a single functioning kidney, which in one case was due to a previous nephrectomy. Hence, we had approximately 4% (95% confidence interval [CI], 0.49-13.71) miscoding of patients in our cohort.

Matching

Using a pool of 3,586 women with 2 kidneys, women with unilateral renal agenesis were matched 1:4 to women with 2 kidneys by age at delivery (within 2 years), race, and history of chronic hypertension. A woman was considered to have chronic hypertension if an *ICD-9* code for this comorbid condition existed. Approach of nearest available neighbor matching without replacement was used.[11] First, we randomly sorted cases (renal agenesis) and controls (2 kidneys). Next, the first case was selected to find its closest control match based on age, race, and history of hypertension. The closest control was selected as a match, and then that control was removed from the pool of available controls. This procedure was repeated for all women with renal agenesis. Of the 205 women with renal agenesis selected for matching, 200 (97.6%) could be matched to 4 women with 2 kidneys and were included in the analysis.

Outcomes

Outcomes were chosen based on previous studies examining adverse outcomes in pregnancy.[12] Adverse maternal and neonatal

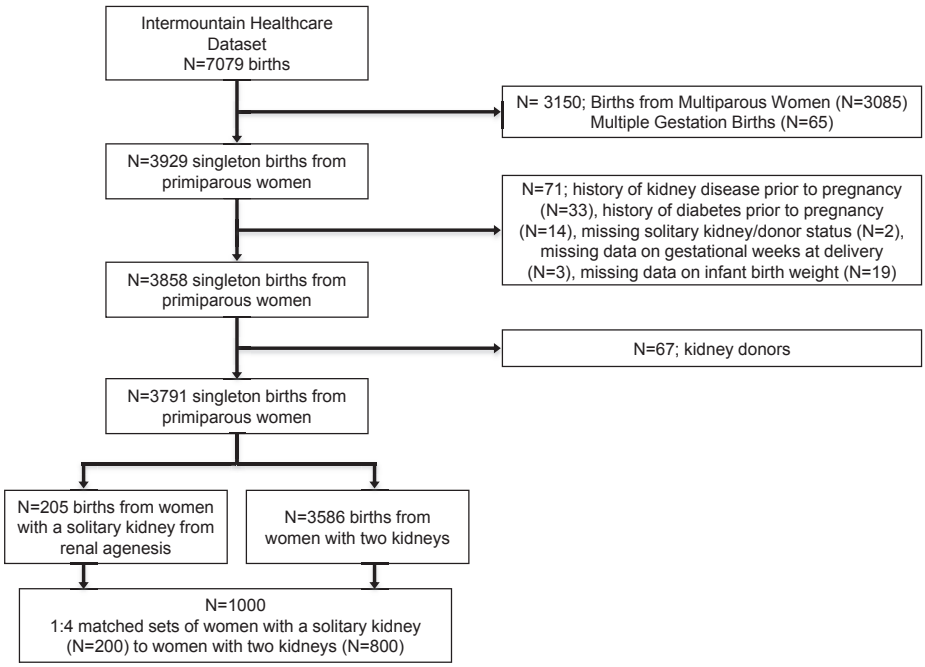

Figure 1. Flow diagram.