



**Sudan University of Science and Technology
College of Graduate Studies**

**Study of Kidneys in Patients with Sickle Cell Disease using
Ultrasonography**

دراسة الكلى لمرضى الخلايا المنجلية باستخدام الموجات فوق الصوتية

**A thesis submitted for the fulfillment of PhD degree in Medical
Diagnostic Ultrasound**

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الآية

قال تعالى:

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ ﴿قَالُوا سُبْحَانَكَ لَا عِلْمَ لَنَا إِلَّا

مَا عَلَّمْتَنَا إِنَّكَ أَنْتَ الْعَلِيمُ الْحَكِيمُ ﴿صدق الله العظيم

سورة البقرة الآية (32)

Dedication

To my parents (My kind mother **Haram Elabadi** & Great father
Abdalla Elthair)

To my brothers and sisters

To my wife (**Nada Attar**)

And To my kids (**Rahaf, Rana, Ahmed and Abdalla**)

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Abstract

The aim of this study was to evaluate the impact of sickle cell disease (SCD) on kidneys by using ultrasonography. The method adapted was an experimental study among a sample consists of 115 SCD patients and 100 as control group with different gender and age group were selected. The study was carried out in west of Sudan where SCD has been an endemic disease among the community, from the period of August 2014 to March 2017. Right and left kidneys volume and echogenicity were assessed as well as right & left renal arteries resistive and pulsatility indices were measured.

The results analysis carried out by EXCELL software for the collected variables which revealed that, the incidence of SCD among the selected sample was (54.6%) for male and the female represents (45.4%) with mean age of 10.5 ± 4 /years for SCD patients and 17 ± 4.9 /years for control group and their body mass index (kg/m^2) 16.8 ± 3 & 23.2 ± 5.5 for the patients and control group respectively. The right and left kidney volumes (cm^3) were 59.41 ± 2.21 and 98.38 ± 21.38 cm^3 as atrophied relative to control group.

The resistive and pulsatility indices for the right and left renal arteries of patients were ($0.8 \pm 0.2/1.5 \pm 0.4$) and ($0.77 \pm 0.1/1.6 \pm 0.2$) respectively, which were greater than in control group (0.7 ± 0.1 & 1.4 ± 0.4) and (0.7 ± 0.1 & 1.5 ± 0.5), and as well the SCD used to increase the echogenicity of the kidneys.

The study also revealed that; there is a direct proportional linear relationship between RI and BMI for the right renal artery in patients and control group; with prominent increment ($0.011 \text{ kg}/\text{m}^2$) for patient RI relative to control group ($0.004 \text{ kg}/\text{m}^2$). Similarly to PI versus BMI, where it increased by a factor of ($0.053 \text{ kg}/\text{m}^2$) compared with control group ($0.016 \text{ kg}/\text{m}^2$).

For the left renal artery; the RI has direct proportional linear relationship with BMI, as it increases by a factor of ($0.018/\text{kg}/\text{m}^2$) compared with the control groups which were ($0.004/\text{kg}/\text{m}^2$). Similarly the PI has direct proportional

relationship with BMI, where it increases by a factor of $(0.050/\text{kg}/\text{m}^2)$ relative to control group which were $(0.018/\text{kg}/\text{m}^2)$.

Since the sickle cell disease has an impact in kidneys, the worth outcome of this study proved that: Kidneys ultrasonography as kidneys volume, echogenicity and renal artery RIs & PIs could be used successfully as early sonographic predictors of kidneys changes for SCD and/or other diseases which could have same or similar impact in the kidneys at early stage.

After successful finishing of this study we recommend for further studies in the same region, encouraging the population for marriage from non relative ones, establishing more specialized centers with modern equipments and community education about the morbidities of the sickle cell disease.

المستخلص

تهدف هذه الدراسة لتقييم تأثير أمراض الخلايا المنجلية على الكلى باستخدام الموجات فوق الصوتية، وهي دراسة تجريبية تم اختيار عينة مكونة من 115 مريض بالخلايا المنجلية و 100 كمجموعة مرجعية من الجنسين ومختلف الاعمار. وقد أجريت هذه الدراسة في غرب السودان حيث ينتشر مرض الخلايا المنجلية بين المجتمع في الفترة من أغسطس 2014 إلى مارس 2017. تم فحص جميع المشاركين بالموجات فوق الصوتية لقياس حجم الكلى وكمية الصدى للمجوعتين فضلا عن قياس مؤشري المقاومة والنبض للشريان الكلوي في الكليتين.

كانت النتائج كما يلي: نسبة الاصابة بالمرض في الذكور هي (54.6%) أما الإناث فكانت (45.4%)، متوسط العمر لدى المرضى (10.5 ± 4 سنوات) و (17 ± 4.9 سنوات) للمجموعة المرجعية. مؤشر كتلة الجسم (3 ± 16.8) كغ/م² و (23.2 ± 5.5) كغ/م² للمرضى والمجموعة المرجعية على التوالي. كانت أحجام الكلى اليمنى واليسرى (2.21 ± 59.41 و 21.38 ± 98.38 سم³ للمرضى على التوالي.

أيضا كانت قيم مؤشري المقاومة والنبض في الشريان الكلوي للكليتين في المرضى هي: (0.8 ± 0.2) و (0.4 ± 1.5) و (0.77 ± 0.1 / 1.6 ± 0.2) على التوالي، وهي أكبر في المرضى مقارنة بالمجموعة المرجعية. أيضا أظهرت الدراسة زيادة كمية الصدى في الكلى لدى المرضى مقارنة بالمجموعة المرجعية.

وكشفت الدراسة أيضا أن هناك علاقة خطية نسبية مباشرة بين مؤشر المقاومة للشريان الكلوي الأيمن ومؤشر كتلة الجسم في المرضى والمجموعة المرجعية مع زيادة بمقدار (0.011 كغم / م²) للمرضى مقارنة بالمجموعة المرجعية (0.004 كغم / م²). كما كان معدل الزيادة مقارنة مع مؤشر النبض هي 0.053 كغم / م² للمرضى مقارنة بالمجموعة المرجعية (0.016 كغم / م²)، أيضا هنالك علاقة مماثلة لمؤشر المقاومة للشريان الكلوي الأيسر مع مؤشر كتلة الجسم، حيث أنه يزيد بعامل (0.018 / كغم / م²) مقارنة مع المجموعة المرجعية التي تزيد بمعدل (0.004 / كغم / م²) وبالمثل فإن مؤشر النبض له علاقة نسبية مباشرة مع مؤشر كتلة الجسم، حيث يزداد بعامل (0.050) كغم/م² بالنسبة للمرضى مقارنة مع المجموعة المرجعية التي كانت تزيد بمعدل (0.018) كغم/م².

وبما ان فقر الدم المنجلي يؤثر في الكليتين، فان نتائج هذه الدراسة اثبتت ان: دراسة الكلى بالموجات فوق الصوتية وقياس مؤشري المقاومة والنبض للشريان الكلوي من شأنه ان يكون مؤشر مبكر وناجح للدلالة على التغييرات التي يحدثها مرض الخلايا المنجلية أو اي مرض اخر له نفس التأثير على الكلى في المراحل المبكرة.

بعد الانتهاء بنجاح من هذه الدراسة نوصي بإجراء المزيد من الدراسات في نفس المنطقة، وتشجيع السكان للزواج من غير الأقارب، وإنشاء مراكز أكثر تخصصا مزودة بالمعدات الحديثة، بالإضافة لتعليم وتوعية المجتمع حول خطورة ومضاعفات مرض الخلايا المنجلية.

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Abbreviations

ADPKD	Autosomal dominant polycystic kidney disease
AP	Antero-posterior
ARPKD	Autosomal recessive polycystic kidney disease
BBS	Bardet Biedl syndromes
BMI	Body mass index
CKD	Chronic Kidney Disease
Cont	Control
DCT	Distal convoluted tubule
Glu6Val	Glutamic acid to valine
Hb S	Haemoglobin S
HbSS	Haemoglobin SS
HgbS	Sickle-cell haemoglobin
HgbSC	Haemoglobin C with sickling
HPLC	High-performance liquid chromatography
IEF	Isoelectric focusing
Lt	Left
Lt K vol	Left kidney volume
Lt RA PI	Light renal artery Pulsatility index
Lt RA RI	Light renal artery resistive index
Pat	Patient
PCT	Proximal convoluted tubule
pH	Potential of hydrogen
PI	Pulsatility index
PWV	Pulse wave velocity
RI	Resistive index
Rt	Right
Rt K vol	Right kidney volume
Rt RA PI	Right renal artery Pulsatility index
Rt RA RI	Right renal artery resistive index
SCD	Sickle cell disease
STDEV	Standard deviation
SLE	Systemic lupus erythomatosus
U/S	Ultrasound