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The Interplay Between Chronic Kidney Disease and Fasting Lipid Levels: A Comprehensive Study

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ABSTRACT

Chronic Kidney Disease (CKD) is increasingly recognized for its association with various metabolic disturbances, including dyslipidemia. The impact of age and disease progression on lipid profile remains of considerable interest, with potential implications for cardiovascular risk assessment and therapeutic intervention. To analyze the fasting lipid profile of CKD patients, evaluate its correlation with kidney function and ascertain the clinical significance of observed lipid abnormalities. A cross-sectional study was conducted on 100 CKD patients aged 40-80 years. Lipid parameters including total cholesterol, LDL, HDL and Triglycerides were assessed and associations with kidney function, specifically eGFR, were determined. The mean age of the participants was 58 years with a male predominance (55%). The average Total Cholesterol was found elevated at 220 mg dL^{-1}. LDL stood at a concerning 140 mg dL^{-1}, while HDL was borderline with a mean of 40 mg dL^{-1}. Triglycerides further emphasized dyslipidemia with a mean of 180 mg dL^{-1}. Alarmingly, 70% of patients had cholesterol levels above 200 mg dL^{-1} and 60% exhibited elevated LDL levels. Notably, 50% of patients in advanced CKD stages had exacerbated lipid abnormalities. A significant negative correlation was observed between eGFR and Total Cholesterol (r = -0.65), while a positive correlation existed between deteriorating CKD stages and rising triglycerides (r = 0.5). CKD patients demonstrate a prominent trend of dyslipidemia, escalating with disease progression. This study accentuates the imperative need for routine lipid monitoring and tailored interventions in the CKD population, potentially mitigating associated cardiovascular complications and improving patient outcomes.

INTRODUCTION

Chronic kidney disease (CKD) is a globally recognized health concern that affects millions of individuals. Characterized by a gradual loss of kidney function over time, CKD is often associated with numerous complications, both renal and extrarenal[1]. As the kidneys perform a myriad of essential functions, including filtering waste products, maintaining electrolyte balance and regulating blood pressure, their impairment can disrupt various physiological processes[2].

One of the emerging concerns related to CKD is the interplay between kidney function and lipid metabolism, a relationship that has garnered considerable attention in recent years[3]. Lipids, primarily consisting of cholesterol, triglycerides and their protein carriers, are vital for many body functions. However, their abnormal metabolism can lead to a host of complications, with cardiovascular diseases (CVDs) being the most notable[4]. It's well-documented that CVDs are the leading cause of morbidity and mortality in CKD patients[5]. The link between dyslipidemia (abnormal lipid levels in the blood) and cardiovascular risks in the general population is well-established. However, in the context of CKD, this relationship becomes even more intricate[6].

Dyslipidemia in CKD is distinct from the general population. It is not just the elevation of the "bad" cholesterol or the reduction of the "good" cholesterol; the very nature of lipoproteins can change, leading to increased atherogenic potential[7]. This altered lipid profile in CKD patients has been attributed to various factors, such as reduced lipid clearance, altered lipid synthesis and increased lipid peroxidation. Furthermore, traditional lipid-lowering therapies may not always offer the same protective cardiovascular benefits in CKD patients as they do in those without kidney disease, making the management of dyslipidemia in this cohort challenging[8].

With an aging global population and rising prevalence of risk factors like diabetes and hypertension, the incidence of CKD is projected to increase. Thus, understanding the nuances of lipid metabolism in CKD becomes paramount. Recognizing the types of dyslipidemia that are more prevalent in CKD, understanding the underlying pathophysiology and identifying the potential therapeutic interventions could be pivotal in shaping the management guidelines for this vulnerable group.

Aim and objectives: The primary aim of this study is to delve deeper into the relationship between CKD and lipid metabolism, providing a comprehensive analysis of the fasting lipid profile among CKD patients and its association with disease progression.

To achieve this, the specific objectives are as follows:

- **Profile assessment:** To evaluate the levels of key lipid parameters, including Total Cholesterol, LDL, HDL and Triglycerides, in CKD patients
- **Demographic analysis:** To analyze how age and gender influence lipid profiles in the CKD cohort.
- disease progression correlation: To determine the correlation between deteriorating kidney function (assessed via eGFR) and changes in lipid parameters
- **Clinical implication study:** To ascertain the clinical significance of observed lipid abnormalities, focusing on their potential role in exacerbating cardiovascular risks among CKD patients

MATERIALS AND METHODS

Study setting and design: The study was conducted at Kamineni Institute of Medical Sciences, Narketpally, Telangana, India. This institution is known for its advanced medical facilities and research capacities, making it a suitable venue for this comprehensive study. The study was designed as a cross-sectional observational study, carried out over the course of one year, from January 2013 to December 2013.

Study population: Patients diagnosed with Chronic Kidney Disease (CKD), who were undergoing treatment or check-ups at the Kamineni Institute during the study period, were considered eligible for participation. Exclusion criteria included patients with acute kidney injury, patients already on lipid-lowering medications, those with a history of thyroid dysfunction and patients with concurrent acute inflammatory or infectious diseases which might affect the lipid profile.

Sample size: Based on the prevalence rate of dyslipidemia in CKD and considering the patient inflow in the institute, a convenient sample of suitable CKD patients who met the inclusion criteria during the study period was selected.

Data collection: A structured questionnaire was employed to gather information about the patients' demographic details, medical history, lifestyle factors and other relevant data. Clinical data, including details about CKD staging and recent lab tests, were sourced from medical records with due consent.

Lipid profile assessment: Blood samples were collected from the participants after 12 hrs of fasting. The collected samples were processed in the institute's central laboratory. The lipid profile, including Total Cholesterol, LDL, HDL and Triglycerides, was assessed using standard enzymatic methods.

Kidney function assessment: The estimated glomerular filtration rate (eGFR) was calculated using the modification of diet in renal disease (MDRD) equation. This helped categorize patients into various CKD stages, facilitating the analysis of lipid profile variations across different CKD stages.

Statistical analysis: The data obtained were compiled and analyzed using appropriate statistical software. Descriptive statistics like mean, median and standard deviation were computed for continuous variables. Categorical data were presented as frequencies and percentages. The association between CKD stages and lipid profile abnormalities was tested using the Chi-square test. Correlation analyses were conducted to determine the relationship between eGFR and lipid parameters.

Ethical considerations: The study was approved by the Institutional Ethics Committee, Kamineni Institute of Medical Sciences, Narketpally, Telangana, India. Informed consent was obtained from all individual participants included in the study. Patient anonymity and data confidentiality were maintained throughout.

RESULTS

Sample demographic characteristics of chronic kidney disease patients: Out of the 100 patients, 55% were males, slightly outnumbering females at 45%. The average age of participants was 58, with a wide age range from 40-80 years. This diverse age range indicates a broad spectrum of patients, which may provide insights into how age influences the lipid profile in CKD patients (Table 1).

Lipid profile mean values: Total Cholesterol: With a mean value of 220 mg dL^{-1}, the sample's cholesterol level is above the generally accepted normal range (usually less than 200 mg dL^{-1}). This elevated level suggests that CKD patients might be predisposed to hypercholesterolemia.

LDL: Often termed as 'bad cholesterol', a mean of 140 mg dL^{-1} indicates levels above the recommended limit for general health, suggesting an increased risk for atherosclerosis and other heart diseases in CKD patients.

HDL: An average of 40 mg dL^{-1} is at the borderline level. HDL is often termed as 'good cholesterol' and these lower levels may indicate a decreased protective effect against heart disease.

Table 1: Sample demographic characteristics of chronic kidney disease patients

Parameter	Values
Total patients	100
Male	55%
Female	45%
Average age	58 years
Age range	40-80 years

Triglycerides: The mean triglyceride level of 180 mg dL^{-1} is notably above the optimal range (below 150 mg dL^{-1}), highlighting another lipid metric that CKD patients may be prone to elevate (Table 2).

Prevalence of lipid dysregulation: A striking 70% of CKD patients having total cholesterol levels above 200 mg dL^{-1} strongly indicates a predominant trend of hypercholesterolemia in this demographic.

The fact that 60% of the patients had elevated LDL levels emphasizes the elevated risk for cardiovascular events among these patients.

The reduced HDL levels in 55% of patients, especially considering gender differences, further complicate the cardiovascular risk profile.

The observation that half of the patients in advanced stages of CKD exhibited even higher cholesterol and triglycerides suggests that as kidney function deteriorates, lipid imbalances might exacerbate (Table 3).

Correlation findings: The notable negative correlation between kidney function and total cholesterol signifies that as the kidneys become less efficient (eGFR declines), cholesterol profiles worsen. This could be due to decreased excretion or other metabolic changes.

A positive correlation between worsening CKD stages and increased triglycerides supports the notion that lipid metabolism is significantly affected as kidney health declines (Table 4).

Clinical relevance: The evident dyslipidemia among CKD patients underscores a dual challenge. Not only do they grapple with kidney disease but their cardiovascular risk is also heightened due to altered lipid profiles.

Recognizing this interplay might pave the way for targeted interventions, which could potentially reduce cardiovascular complications, thus improving the quality of life and survival rates among CKD patients.

DISCUSSIONS

The relationship between chronic kidney disease (CKD) and dyslipidemia, as evidenced in our study at Kamineni Institute of Medical Sciences, Narketpally, Telangana, presents intriguing facets that warrant deeper exploration in light of previous research on the topic.

Our study highlighted a marked elevation in total cholesterol, with a mean value of 220 mg dL^{-1} in the CKD cohort. These findings echo those of Attman*et al*.[9] who documented hypercholesterolemia as a consistent feature of CKD, with increasing prevalence as kidney function declines. The elevated cholesterol can be attributed to diminished catabolism

Table 2: Mean values of lipid profile parameters in chronic kidney disease patients

Lipid Parameter	Mean value (mg dL^{-1})	Interpretation/notes
Total Cholesterol	220	Above normal (<200 mg dL^{-1}), risk of hypercholesterolemia
LDL	140	Above recommended limit, risk of atherosclerosis
HDL	40	Borderline, reduced protective effect against heart disease
Triglycerides	180	Above optimal (<150 mg dL^{-1})

Table 3: Prevalence of lipid dysregulation in chronic kidney disease patients across different stages

Finding	Patients (%)
Elevated total cholesterol (>200 mg dL^{-1})	70
Elevated LDL levels	60
Reduced HDL levels (males <45 mg dL^{-1}, females <55 mg dL^{-1})	55
Higher cholesterol and triglycerides in advanced CKD	50

Table 4: Correlation findings between kidney function (eGFR) and lipid parameters in chronic kidney disease patients

Correlation between	Values	Interpretation/notes
Kidney function and total cholesterol	r = -0.65	Cholesterol worsens as eGFR declines
CKD progression and triglycerides	r = 0.5	Lipid metabolism affected as kidney health declines

of lipoproteins, a phenomenon that has been further elucidated by Vaziri, suggesting that impaired renal function reduces cholesterol breakdown and elimination[10].

Another pivotal finding was the elevated LDL levels, averaging 140 mg dL^{-1}. Studies, such as the one by Tsimihodimos *et al*.[11] have observed that LDL particles in CKD patients are more atherogenic than in the general population due to their heightened susceptibility to oxidation. This modified LDL structure not only substantiates our findings but also accentuates the cardiovascular risks faced by CKD patients.

The diminished HDL levels, with an average of 40 mg dL^{-1} in our study, underline another layer of complexity. This is not merely about the quantity of HDL but also its function. As supported by Holzer *et al*.[12] the anti-inflammatory and antioxidative functions of HDL seem compromised in CKD, making it less cardioprotective.

Furthermore, our observation of a mean triglyceride level of 180 mg dL^{-1} sheds light on hypertriglyceridemia as another lipid anomaly prevalent in CKD patients. A study by Baigent *et al*.[13] had previously emphasized that heightened triglyceride levels, coupled with the presence of other lipid irregularities, contribute significantly to the amplified cardiovascular disease risk in CKD patients.

A particularly intriguing aspect of our research was the correlation between deteriorating kidney function and worsening lipid profiles. The negative correlation with eGFR and cholesterol levels, in particular, can be juxtaposed with findings from the chronic renal insufficiency cohort (CRIC) Study, which had reported a similar trend across its diverse participant base[14].

The clinical implications of our findings, when juxtaposed with prior research, cannot be understated. Not only do they reiterate the cardiovascular risks faced by CKD patients due to lipid imbalances but they also stress the necessity for tailored interventions. Given that traditional lipid-lowering therapies might not yield consistent results across CKD stages, as emphasized by Wanner a more nuanced approach becomes indispensable.

CONCLUSION

Our study sheds light on the intricate relationship between chronic kidney disease (CKD) and lipid profile abnormalities. The elevated levels of total cholesterol, LDL and triglycerides, along with diminished HDL, underscore the heightened cardiovascular risk in CKD patients. These findings emphasize the urgency of tailored interventions to manage dyslipidemia in CKD, potentially mitigating cardiovascular complications and improving patient outcomes. Further research is warranted to explore targeted therapeutic strategies for this vulnerable population.

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