Clinical Implications of Incidental Medical and Laboratory Findings in Preoperative Valvular Heart Disease Patients – A South Eastern Nigerian Experience

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Abstract

BACKGROUND

Valvular heart diseases with their varying aetiologies are becoming common in developing countries. Certain biochemical abnormalities exist in this group of patients which may contribute to adverse outcomes. It is imperative for clinicians to promptly and adequately identify these abnormalities where and when they occur for optimal patient outcomes. The study aimed to describe the incidental medical and laboratory abnormalities seen in valvular heart disease patients presenting for open heart surgery.

METHODOLOGY

This was a retrospective hospital-based study. Relevant data were extracted from patients' folders, cleaned and analyzed. The study was carried out at the University of Nigeria Teaching Hospital, Enugu, Nigeria. The study involved adult patients evaluated for heart surgery. The outcome measure was the proportion of participants with deranged biochemical parameters.

RESULTS

A total of 51 patients with a mean (SD) age of 42.84 (15.0) years and an M: F ratio of 1:1.4 were involved in the study. Mitral valve regurgitation = 22 (43.14%) was found to be the commonest disorder among surveyed participants. The commonest electrolyte abnormalities were hyponatraemia 14 (27.45%) and hypokalaemia 6 (11.76%) respectively. A total of 8 (15.69%) and 9 (17.65%) patients had elevated creatinine and urea levels respectively, while 3 (5.88%) of the participants had their blood glucose levels in the diabetic range.

CONCLUSION

Hyponatraemia and hypokalaemia were the commonest electrolyte abnormalities. Hyperglycaemia, elevated urea and creatinine as well as deranged eGFR were other abnormal findings.

Keywords: *Mitral Valve Regurgitation, Mitral Valve Stenosis, Aortic Valve Regurgitation, Hyponatraemia, Hypokalaemia*

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Introduction

Valvular heart diseases (VHDs) consist of a myriad of diseases affecting the heart valves. These diseases include Mitral Regurgitation (MR), Mitral Stenosis (MS), Aortic Regurgitation (AR), Aortic Stenosis (AS), Tricuspid regurgitation (TR), Tricuspid Stenosis (TS), Pulmonary Regurgitation (PR) and Pulmonary Stenosis (PS). A mixed disease is when stenosis and regurgitation coexist in the same valve while two or more valves may be diseased in the same individual.

The management of these valvular heart diseases includes surgical procedures in the form of valve repair or valve replacement which in turn can either be via traditional open heart surgery or minimally invasive methods. In many developing countries, including Nigeria, traditional open heart surgery is still the mainstay of surgical intervention. The causes of VHDs are varied and include congenital causes, rheumatic fever, cardiomyopathy, and age-related causes. Whilst rheumatic heart disease remains the most prevalent cause in developing countries, degenerative causes are currently more prevalent in industrialized nations.[1,2] This shift from rheumatic heart disease to degenerative causes in the industrialized nations reflect ageing and an overall decreased incidence of rheumatic fever.

A study done in Kano, Nigeria reported a prevalence of 9.8% Rheumatic Heart Disease(RHD) over four years, with mitral regurgitation being the commonest (34.00%) abnormality seen.[3] In Mozambique,[4] sub-Saharan Africa, a very high prevalence of RHD of 30.4 per 1000 was documented while a prevalence of 14.03 per 1000 was recorded in Congo.[5]

VHDs have become a public health problem as a study by Nkomo *et al* [6] recorded that the national prevalence of valve disease, corrected for age and sex distribution from the US 2000 population, was 2.5%. Prevalence increased with age, from 0.7% (95% CI 0.5-1.0) in 18-44 year-olds to 13.3% (11.7-15.0) in the 75 years and older group.

Serum sodium (Na), potassium (K), and calcium (Ca2+) are the major determinants of electrophysiological properties of the myocardial membrane.[7] These electrolytes play important roles in cellular metabolism, energy transformation and the regulation of cellular membrane potentials, especially those of muscle and nerve cells.[8]

Certain biochemical abnormalities, notably hyperkalaemia and hyponatraemia, have been described [9,10] among individuals with VHDs and life-threatening electrolyte abnormalities are known to affect the prognosis and outcome of disease states. Again electrolyte imbalances are equally associated with increased cardiovascular morbidity and mortality. [11]

Though a lot of literature abounds in the area of VHDs there is a dearth of data describing these biochemical abnormalities in VHDs. Prompt identification and adequate management of these abnormalities are important for the overall outcome of both the surgical correction and subsequent management of the VHD patient. The current study, therefore, is aimed at describing the incidental medical and laboratory abnormalities seen in VHD patients presenting for open heart surgery in the study area.

Methodology

Study location

The study was conducted at the Cardiothoracic Unit of the University of Nigeria Teaching Hospital (UNTH), the National Cardiothoracic Centre of Excellence located in Enugu South East Nigeria. The centre has remained at the forefront of research in cardiovascular medicine and surgery, catering for over 50 million residents of South East, South-South and North Central Nigeria.

Study design

This was a descriptive retrospective hospital-based study of patients evaluated for heart surgery at the Cardiothoracic Center from 2013 to 2017. Patients' folders were retrieved and data including age, sex, and diagnosis were extracted. Diagnosis of VHD was based on case notes, and relevant results of investigations as requested by the attending Cardiologists at the time of Clinic visit, admission, or discharge.

Results of laboratory investigations done as part of the evaluation in the Clinic and Wards were studied and relevant data was collated.

Study participants

Adult patients aged 18 years and above seen at the Cardiology Clinics or referred from other Clinics and Hospitals with a clinical or echocardiographic diagnosis of VHD. Paediatric patients, non-valvular heart disease patients and case folders of valvular heart disease patients with incomplete data were excluded.

Statistical analysis

Statistical analysis was done using descriptive statistics. Data were double-entered into a Microsoft Excel spreadsheet and analysis was carried out using Epi Info 3.5.1(CDC, Atlanta, GA, USA). Continuous variables were summarized as means (standard deviation [SD]), numbers and percentages while Categorical variables were presented as proportions (numbers) and percentages.

Generally, designated reference intervals were used to categorize the variables (biochemical test analytes) into low, high and levels within specified reference intervals.

Ethical consideration

Ethical clearance was obtained from the University of Nigeria Teaching Hospital Health Research Ethics Committee. There were no ethical violations in the conduct of this study.

Results

The study included a total of 51 patients with a mean (SD) age of 42.84 (15.0) years and an M: F ratio of 1:1.4. Majority = 42 (82.35%) were of Igbo extraction, with the highest level of education being secondary school level = 34 (66.67%). The demographic characteristics are described in Table 1.

Mitral valve regurgitation = 22 (43.14%) was found to be the commonest disorder among surveyed participants, (see Table 2) while biventricular failure 5 (9.80%) was noted to be the commonest complication. The majority of 40 (78.43%) of the patients had no associated co-morbidity, Table 3.

The biochemical parameters tested at baseline were as follows; Sodium, potassium, urea, creatinine, and Fasting plasma glucose. Creatinine values were used to calculate the estimated Glomerular Filtration Rate (eGFR) using Chronic Kidney Disease Epidemiology Collaboration (CKD-EPI) formula [12] as shown in Table 7.

The commonest sodium and potassium abnormalities were hyponatraemia = 14 (27.45%) and hypokalaemia = 6 (11.76%) respectively, Table 4. A small percentage = 3 (5.88%) of the participants had their glucose levels in the diabetic range ($\geq$ 7.0 mmol/L), Table 5.

A total of 8 (15.69%) and 9 (17.65%) patients had elevated creatinine and urea levels respectively, Table 6. The majority of the participants, 31 (60.78%) had their eGFR $\geq$90 ml/min/1.73m^2 followed by 14 (27.45) %) with eGFR 60 – 89 ml/min/1.73m^2, Table 7.

Table 1:
Demographic characteristics of valvular heart disease patients

S/N		Mean (SD)
1	Age (years)	42.84 (15.0)
2	Age groups	Number (%)
	18 – 30	10 (19.60)
	31 – 40	13 (25.49)
	41 – 50	12 (23.53)
	51 – 60	8 (15.69)
	>60	8 (15.69)
2	Sex	Number (%)
	Male	21 (41.18)
	Female	30 (58.82)
	Total	51 (100.00)
	M: F ratio	1: 1.4
3	Tribe	Number (%)
	Bini	1 (1.96)
	Birom	2 (3.92)
	Edo	1 (1.96)
	Igbo	42 (82.35)
	Ijaw	1 (1.96)
	Itsekiri	2 (3.92)
	Tiv	1 (1.96)
	Yoruba	1 (1.96)
	Ibibio	1 (1.96)
	Total	51 (100.00)
4	Occupation	
	Civil Servant	15 (29.41)
	Retired Civil Servant	2 (3.92)
	Artisan	2 (3.92)
	Clergy	1 (1.96)
	Driver	3 (5.88)
	Student	8 (15.69)
	Tailor	2 (3.92)
	Trading	12 (23.53)
	Unemployed	6 (11.77)
	Total	51 (100.00)
5	Level of Education	
	Primary	7 (13.73)
	Secondary	34 (66.67)
	Tertiary	10 (19.60)
	Total	51 (100.00)

Table 2:
Distribution of patients according to the type of valvular disease

S/N	Type of Disease	No (%)
1	Mitral Regurgitation (MR)	22 (43.14)
2	Mitral Stenosis (MS)	8 (15.69)
3	Mixed Mitral valve disease (MVR + MVS)	3 (5.88)
4	Aortic Regurgitation (AR)	5 (9.80)
5	Aortic Stenosis (AS)	1 (1.96)
6	Double valve disease	12 (23.53)
7	Mixed Aortic Valve Disease (AR + AS)	0 (0.00)
8	Total	51 (100.00)

Legend: MR = Mitral Regurgitation; MS = Mitral Stenosis; MVR = Mitral Valve Regurgitation; MVS = Mitral Valve Stenosis; AR = Aortic Regurgitation; AS = Aortic Stenosis

Table 3:
List of co-morbidities

S/N	Comorbidity	No (%)
1	Diabetes mellitus (DM) alone	1 (1.96)
2	DM + Hypertension	2 (3.92)
3	HHD alone	3 (5.88)
4	Hypertension	3 (5.88)
5	Stroke	2 (3.92)
6	No comorbidity	40 (78.43)
7	Total	51 (100.00)

Table 4:
Sodium and potassium abnormalities

Type of Disease	↓ Na N (%)	↑ Na N (%)	↔ Na N (%)	Total N (%)	↓ K N (%)	↑ K N (%)	↔ K N (%)	Total N (%)
Mitral regurgitation	6 (27.27)	2 (9.09)	14(63.64)	22(100)	5 (22.73)	1 (4.55)	16(72.73)	22 (100)
Mitral stenosis	3 (37.50)	1 (12.50)	4 (50.00)	8(100)	0 (0.00)	1 (12.50)	7(87.50)	8(100)
Mixed Mitral valve disease	3 (100)	0 (0.00)	0 (0.00)	3(100)	0 (0.00)	0 (0.00)	3 (100)	3(100)
Aortic regurgitation	0 (0.00)	0 (0.00)	5 (100)	5(100)	0 (0.00)	0 (0.00)	5 (100)	5(100)
Aortic valve stenosis	0 (0.00)	0 (0.00)	1 (100)	1(100)	0 (0.00)	0 (0.00)	1 (100)	1(100)
Double valve disease	2 (16.67)	0 (0.00)	10(83.33)	12(100)	1 (8.33)	2 (16.67)	9(75.00)	12(100)
Total	14(27.45)	3 (5.88)	34(66.67)	51 (100)	6(11.76)	4 (7.84)	41(80.39)	51(100)

Table 5:
Distribution of patients with elevated fasting glucose levels

Type of Disease	No	IFG range* (mmol/L)	Diabetic range (mmol/L)
Mitral valve regurgitation	22	0 (0.00)	1 (4.55)
Mitral valve stenosis	8	0 (0.00)	0 (0.00)
Mixed Mitral valve disease	3	0 (0.00)	0 (0.00)
Aortic valve regurgitation	5	0 (0.00)	1 (20.00)
Aortic valve stenosis	1	0 (0.00)	1 (100.00)
Double valve disease	12	2 (16.67)	0 (0.00)
Total	51	2 (3.92)	3 (5.88)

* IFG = Impaired Fasting Glucose
NB: Impaired fasting Glucose and diabetic range glucose were defined as glucose levels of 6.1 – 6.9 mmol/L and ≥ 7.0 mmol/L respectively.[15]

Table 6:
Urea and Creatinine abnormalities

S/N	Type of VHD	No	↑Creatinine (µmol/L)	↔ Creatinine (µmol/L)	↑ Urea (mmol/L)	↔ Urea (mmol/L)
1	Mitral valve regurgitation	22	3 (5.88)	19 (37.25)	3 (5.88)	19 (37.25)
2	Mitral valve stenosis	8	2 (3.92)	6 (11.76)	4 (7.84)	4 (7.84)
3	Mixed Mitral valve disease	3	0 (0.00)	3 (5.88)	0 (0.00)	3 (5.88)
4	Aortic valve regurgitation	5	1 (1.96)	4 (7.84)	1 (1.96)	4 (7.84)
5	Aortic valve stenosis	1	1 (1.96)	0 (0.00)	0 (0.00)	1 (1.96)
6	Double valve disease	12	1 (1.96)	11 (21.57)	1 (1.96)	11 (21.57)
7	Total	51	8 (15.69)	43 (84.31)	9 (17.65)	42 (82.35)

Legend: VHD = Valvular Heart Disease

Table 7:
Pattern of eGFR (CKI-EPI)

Type of VHD	No	eGFR (CKI-EPI) ml/min/1.73m^2				
		≥ 90	60-89	45-59	30-44	15-29
Mitral valve regurgitation	22	16 (31.37)	3 (5.88)	3 (5.88)	0 (0.00)	0 (0.00)
Mitral valve stenosis	8	3 (5.88)	4 (7.84)	0 (0.00)	1 (1.96)	0 (0.00)
Mixed Mitral valve disease	3	2 (3.92)	1 (1.96)	0 (0.00)	0 (0.00)	0 (0.00)
Aortic valve regurgitation	5	2 (3.92)	2 (3.92)	1 (1.96)	0 (0.00)	0 (0.00)
Aortic valve stenosis	1	0 (0.00)	1 (1.96)	0 (0.00)	0 (0.00)	0 (0.00)
Double valve disease	12	8 (15.69)	3 (5.88)	0 (0.00)	0 (0.00)	1 (1.96)
Total	51	31 (60.78)	14 (27.45)	4 (7.84)	1 (1.96)	1 (1.96)

Legend: VHD = Valvular Heart Disease

Discussion

The age group with the highest number of cases in this study was 31 – 40 years. This is consistent with the observation that in Western society, VHDs affect more of the elderly while the young are affected more in developing countries.[14] Females were more than males in this study. However, studies done in the US, have shown no gender prevalence in the epidemiology of VHDs, although there are important gender differences in their management.[15]

Mitral regurgitation found in 22 participants (43.14%) was the commonest disorder in this study while Mixed Aortic valve disease (0.00%) was the least common. This is in agreement with a study done in Northern Nigeria which equally recorded the highest prevalence of MR (38.0%) and the least prevalence of Mixed Aortic Valve disease (1.6%) among participants.[16] It is equally in agreement with a previous study done in Enugu, Nigeria which also recorded the highest prevalence of MR among participants.[17]

In other studies,[14,18] MR and AS contributed to a majority of cases in Western countries albeit in the elderly. In the Swedish population, [18] Mitral Regurgitation (24.2%) was second to Aortic Stenosis (47.2%).

Electrolyte abnormalities seen in this study include hyponatraemia, hypokalaemia, hypernatraemia and hyperkalaemia, though hyponatraemia and hypokalaemia were more frequently seen than hypernatraemia and hyperkalaemia. This is in contrast with a study done in Pakistan where all VHD patients surveyed had hypernatraemia and hyperkalaemia.[10] The reason for this disparity is however not clear though the types of VHDs studied were not stated in the Pakistan study. The differences in location, age and sex of studied participants may equally be contributory.

It is documented that hypokalaemia and hyponatraemia increase the occurrence of atrial fibrillation as they differentially modulate the Sinoatrial node and pulmonary vein electrical properties.[19] In another study, atrial fibrillation (AF) was found to be more prevalent in outpatients with heart failure and reduced ejection fraction (HFrEF) and hyponatraemia than in those with HFrEF and normonatraemia. The study equally suggested that hyponatraemia is independently associated with the occurrence of AF. Mild MR may be asymptomatic but when the condition becomes severe, the individual may present with palpitations, often due to atrial fibrillation.

Urgent correction of electrolyte imbalance of hyponatraemia and hypokalaemia in patients with severe VHD is, therefore, necessary to mitigate the development of AF and its consequences.

Preoperative hypokalaemia in patients awaiting surgical procedures has also been shown to predispose to perioperative arrhythmia and increased the need for cardiopulmonary resuscitation.[20] This is because normal serum potassium is necessary for the normal transmission of electrical impulses in the myocardium.

A minimal number of participants were noted to have elevated plasma glucose. Only one of the three patients with plasma glucose levels in the diabetic range was a known diabetic. It then follows that 4 out of 5 (80.00%) of the patients with elevated plasma glucose levels were incidental findings. This brings forth one importance of baseline investigations. It is known that individuals with impaired fasting plasma glucose are at high risk of progression to type 2 diabetes, hence this finding emphasizes the need for affected individuals to optimize lifestyle modifications to prevent or delay progression to overt diabetes mellitus.

Concerning urea and creatinine abnormalities, 9 (17.65%) and 8 (15.69%) of participants had elevated levels of urea and

creatinine respectively whereas 20 (39.22%) of participants had eGFR <90 ml/min/1.73m^2. This is expected as eGFR is a more specific measure of kidney function. Because direct measurement of kidney excretory function is impracticable for routine clinical practice, creatinine measurement which is an indirect indicator of glomerular filtration rate is usually done. However, in the past few years, the USA National Kidney Foundation and the European Best Practice Guidelines have both recommended the use of eGFR rather than serum creatinine for the assessment and monitoring of renal function.[21,22] The importance of this finding lies in the fact that the existence of CKD puts an individual at risk of CVDs.[23] Hence, CKD in an individual who already has a cardiac disorder is faced with a double cardiovascular risk. eGFR is very important in considering the choice of drugs and also the dosing of potentially renal toxic drugs. It is pertinent therefore to monitor and appropriately manage patients with deranged kidney function especially those with eGFR < 60 ml/min/1.73m^2 for a better cardiovascular outcome in particular and overall patient outcome in general.

Strengths and Limitations of Study

Inability to document evidence of kidney disease like proteinuria, and haematuria using further renal assessment tests. This would have assisted in further classification of participants with eGFR ≥90 ml/min/1.73m2 into those with normal kidney function and those with CKD Stage I.

The study however gives a snapshot of the pattern of biochemical abnormalities in this group of patients and aids in filling the currently existing wide gap in this subject area.

Conclusion

Electrolyte imbalance was the common finding while elevated blood glucose and deranged eGFR were less observed. Proper and prompt biochemical evaluation of VHD patients will help identify and correct these biochemical abnormalities and prevent possible related complications that may occur in the medical and surgical management of these patients, thereby enhancing good clinical outcomes.

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