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RESEARCH ARTICLE

CARDIAC RHYTHM DISORDERS AND HYDROELECTROLYTIC ABNORMALITIES IN CHRONIC HEMODIALYSIS PATIENTS: IS THERE A CORRELATION?

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Abstract

Introduction: Sudden death is most often due to severe arrhythmias such as ventricular fibrillation which are responsible for 25% of deaths. This is the first cause of death in the chronic hemodialyzed patient.

Purpose: To study electrocardiographic disorders and metabolic abnormalities in chronic hemodialyzed patient before , during and after the hemodialysis session.

Materials and Methods: This is a descriptive, prospective and analytical study carried out in collaboration with the Department of Cardiology and Nephrology of the University Hospital of Marrakech, over a period of 6 months including 56 chronic hemodialyzed patients who received a 24-hours electrocardiogram (EKG) and a biological check-up before and after their hemodialysis session.

Results: The average age of our patients was 49.89 years with extremes ranging from 16 to 86 years. Female predominance was noted (51.78%) with an M/F sex ratio of 0.9. Causal nephropathy is undetermined in 44.6% of cases. Vascular initiation was by venous arterial fistula in 98.2% of cases. Sinus tachycardia was objectified in 9% of cases during dialysis and 7% after the session. The duration of the corrected QT was an average of 441ms, 445ms and 430ms before and after hemodialysis respectively with a statistically significant decrease. Isolated ventricular extrasystoles were objectified in 23.2% of the cases before, 26.8% of the cases during and 48.2% of the cases after the hemodialysis session. Hyperkalemia was noted in 82.1% of cases in before dialysis and hypercalcemia in 16.1% of cases after dialysis.

Conclusion: Metabolic variations during dialysis can lead to a significant risk of cardiac arrhythmias. Chronic hemodialysis should therefore benefit from regular monitoring of electrolytes and cardiovascular status to reduce morbi-mortality on dialysis.

Introduction:-

The annual mortality rate of hemodialyzed patients according to the 2014 French Kidney Registry was 15.5% of which 25% of these cardiovascular deaths and 11% of sudden death [1]. Cardiac arrhythmias are very sensitive to

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changes in volemia and electrolytes and occur frequently in hemodialyzed patients. Supraventricular arrhythmias and ventricular extrasystoles can occur in 20-88% and 76-100% of hemodialysis sessions respectively. The prevalence of atrial fibrillation in hemodialyzed patients ranges from 4.5% to 27%, depending on age, number of years spent on dialysis, and comorbidities. This is significantly higher than in the general population. Similarly, the average incidence of this arrhythmia is estimated at 2.7% per year in this population. At the ventricular stage, arrhythmias ≥ 3 according to the LOWN classification were reported in 13-37% of patients [2-3]. The purpose of our work is to study and describe electrocardiographic disorders on the one hand, and metabolic abnormalities on the other, in chronic hemodialysis before during and after the hemodialysis session and to objective a possible relationship between arrhythmias and electrolyte abnormalities including dyskaliemia.

Materials and Methods:-

This is a descriptive prospective analytical study carried out in collaboration between the Department of Cardiology and Nephrology of the University Hospital of Marrakech, over a period of 6 months from May to October 2018. We included 56 chronic hemodialyzed patients either all patients of the hemodialysis center of the hospital IBN TOFAIL of Marrakech without particle selection with the exception of three patients followed for neuropsychiatric pathology. The hemodialysis age was greater than 12 months. Our patients are considered to be properly dialyzed by a ratio of Kt/V > 1.2 (K: the clearance of the filter urea which defines the performance of the dialysiist; t: time of the hemodialysis session in minutes; V: total volume of water contained in the patient's body expressed in litres). The dialysate used was bicarbonate, with a fixed concentration of sodium (138 mmol/l), calcium (1.5Meq/l), potassium (2-3 mmol/l), magnesium (0.5mmol/l). In our study, dyspnea was present in 53.6% of cases, including 26 cases with dyspnea class II (NYHA). Intermittent chest pain was experienced in 2 patients (3.5% of cases). Paroxystic palpitations were noted in 6 patients (10.7% of cases). There were no cases of syncope. Systolic blood pressure averaged 131.4 + /- 22 mmhg. Diastolic blood pressure averaged 71 +/-13 mmhg. The heart rate averaged 78+/- 10. Note that the LV ejection fraction was preserved in 96.4% of cases (54 patients). We have carried out in all our patients an 24 hours electrocardiogram (EKG) installed 2 hours before their hemodialysis session and this to cover the period per and post-dialysis on the one hand and a biological balance including kaliemia, natremia, calcemia, urea, creatinine and this before and after hemodialysis. The data collection is carried out using a pre-established sheet and the analysis of the results was carried out using the SPSS 20 software. The difference is considered significant if $p<0.05$.

Results:-

The average age of our patients was 49.89 years with extremes ranging from 16 to 86 years. A slight female predominance was noted (51.78% of cases) with an M/F sex ratio of 0.9. The majority of our patients had standard social insurance coverage. 10 patients (17.8% of cases) were diabetic; 24 were hypertensive (43% of cases); 16% of our patients had dyslipidemia; 10 patients were smoking (17.8% of cases). Heart disease was reported in 8 patients, 3 of whom had ischemic heart disease. Causal nephropathy is undetermined in 44.6% of cases (25 patients), diabetic in 17.8% of cases and hypertensive in 16% of cases (9 patients). Hemodialysis had an average age of 7.3 +/- 6.8 years. 87% of our patients (49 patients) had two sessions per week or 9 hours on average. Vascular initiation was by arterial venous fistula (AVF) in 98.2% of cases (55 patients) and by tunneled catheter in 1 patient. Venous arterial fistula was radiocephalic in 50% of cases (28 patients) and brachiocephalic in 48.2% of cases (26 patients).

24 hours electrocardiogram:

The heart rate was regular in all our patients. Sinus tachycardia was objectified in 9% of cases during dialysis and 7% after the session. Left atrial hypertrophy was noted in 39.3% of cases. Right atrial hypertrophy was noted in 17.9% of cases. An incomplete left branch block was diagnosed in 3 patients. Left ventricular hypertrophy was noted in 25% of cases (14 patients). No cases of atrial fibrillation were diagnosed. A large QRS was found in 12.5% of the cases (7 patients). Isolated ventricular extrasystoles were objectified in 23.2% of the cases (13 patients) before, in 26.8% of the cases (15 patients) during and 48.2% of the cases (27 patients) after the hemodialysis session. Duplicate supraventricular extrasystoles were noted in only 1 patients before , in 3 patients during and in 6 patients after dialysis. Isolated supraventricular extrasystoles were highlighted in 42.9% (24 patients), 64.3% (36 patients) and 73.2% (41 patients) before , during and after their hemodialysis sessions respectively. Duplicate supraventricular extrasystoles were found in 16.1% of cases (9 patients) before hemodialysis, 23.2% of cases (13 patients) during and 25% of cases (14 patients) after the session. Other electrical changes are shown in Table I:

Table 1:- Electrical data before and after haemodialysis.

	Before dialysis	During dialysis	After dialysis
Average duration of QRS	93,8 +/-16,2ms	97+/-16,9	97,8+/-18ms
Amplitude of the QRS	15,4mm+/-7	15,17+/-7,3mm	10,1+/-7mm
Average duration of QTC	441ms +/-12	445 ms+/- 9,5	430ms +/- 5
Amplitude of the T wave	4,8 mm +/-2	5,6+/-4 mm	3,5+/-1,9mm
Ventricular extrasystole (VE)	26,8%	39,3%	51,8%
Supraventricular extrasystole (SVE)	48,2%	54,3%	69,6%
Auriculoventricular block (1st degree)	14,2%	19,7%	14,2%

Table 2:- Comparison of electrical data before and after haemodialysis.

	Before dialysis	After dialysis	P value
Average duration of QRS	93,8ms +/-16,2	97,8ms +/-18	0,000
Amplitude of the QRS (R wave)	15,4+/- 7mm	10,1+/-7mm	0,001
Average duration of QTC	441 ms +/-12	430ms+/- 5	0,003
Amplitude of the T wave	4,8 mm +/-2	3,5+/-1,9	0,001
Supraventricular extrasystole (SVE)	48,2%	69,6%	0,011
Ventricular extrasystole (VE)	26,8%	51,8%	0,1
Sokolow Index	35+ /- 6mm	25+/8mm	0,012

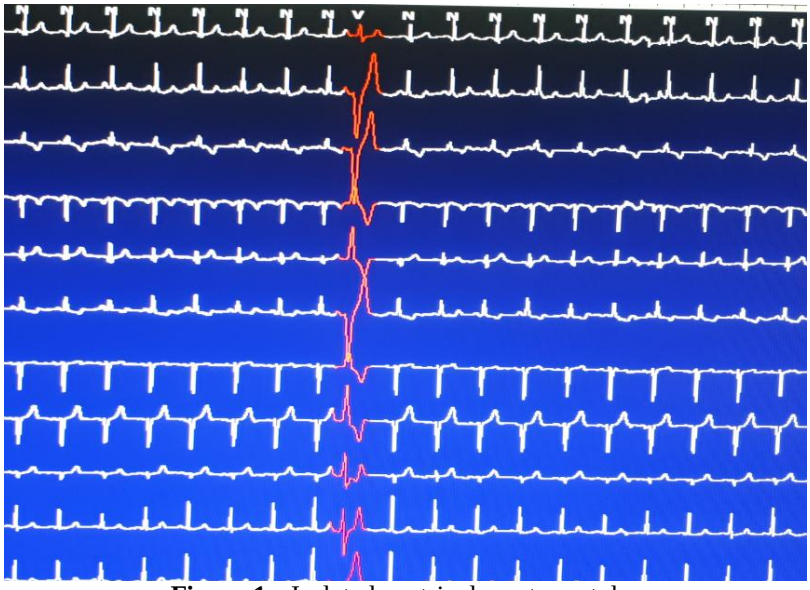
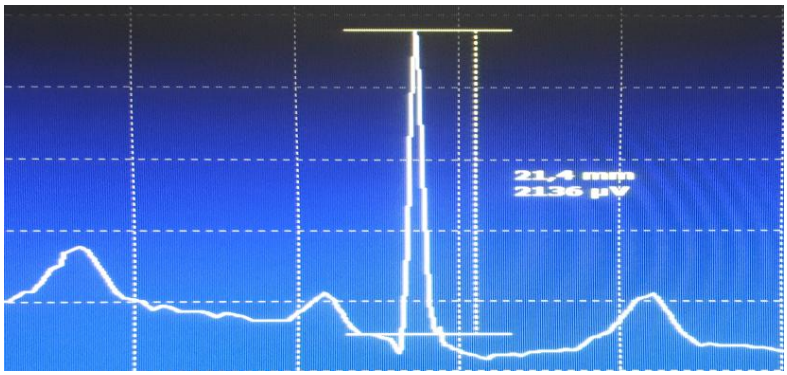


Figure 1:- Isolated ventricular extrasystole.

BEFORE



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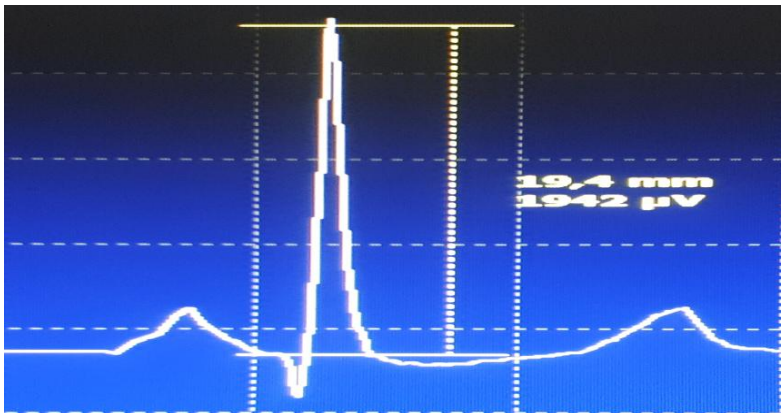
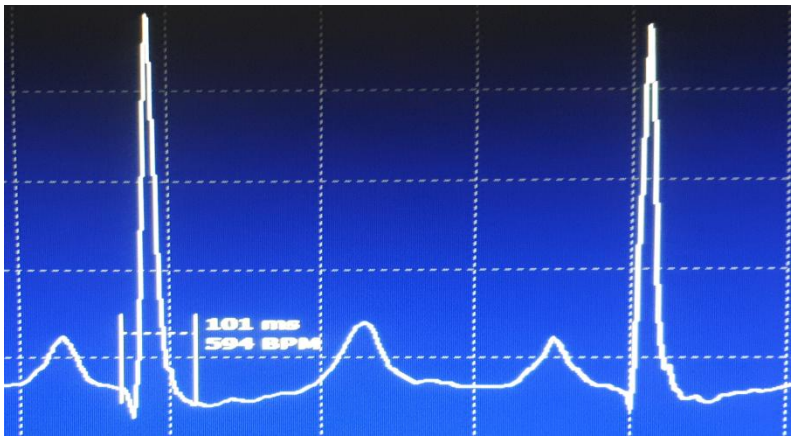


Figure 2:- Trace for decreased qrs amplitude after hemodialysis.

BEFORE



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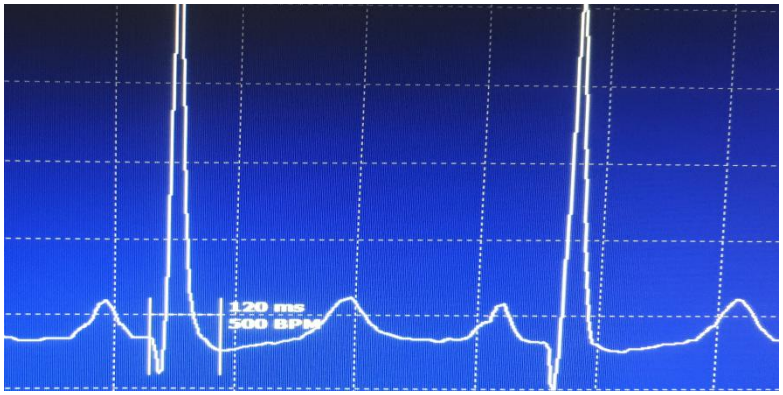

Figure 3:- Trace for an increase of qrs duration after hemodialysis.

Biology:

Hyperkalemia was noted in 82.1% of cases (46 patients) on pre-dialysis with an average of 5.6 mmol/L+/-2.2 before and 3.5 mmol/l+/- 1.5 after the session. Calcemia averaged 85.4 mg/l +/- 7 before and 93.2 mg/l +/- 9.3 after hemodialysis session. Hypercalcemia was found in 16.1% of post-dialysis cases (9 patients). Natremia averaged 136.2 mmol/l +/- 12 before and 137 mmol/l +/-12.2 after haemodialysis. Urea averaged 1.2+/- 0.4 g/l before and 0.8 g/l after dialysis. The mean for Creatinine was 96.6+/-32 mg/l and 33.3+/-16 mg/l before and after hemodialysis, respectively.

Table 3:- Comparison of biological data before and after haemodialysis.

	Before dialysis	**After dialysis**	**P value**

Kaliemia	5,6+/-2,2 mmol/l	3,5+/-1,5mmol/l	0,000
Calcemia	85,4+/-7 mmol/l	93,2+/-9,3mmol/l	0,02
Natremia	136 ,2+/- 12	137+/-12,2	0,5
Urea	1,2+/- 0,4 g/l	0,8 g/l +/-0,2	0,8
Creatinine	96,6+/-32 mg/l	33,3+/-16mg/l	0,000

Correlation:

During this study, we found:

A statistically significant correlation between decreased kaliemia and increased post-dialysis QRS duration (p=0.013).

1. A correlation between decreased T-wave amplitude and decreased post-dialysis kaliemia (p=0.023).
2. A correlation between the occurrence of SVE and the decrease in QTC. (p=0.001).
3. A correlation between the occurrence of VE and the decrease in QTC. (p=0.004).
4. No correlation was noted between the occurrence of extrasystolics and the duration or amplitude of the QRS on the one hand; and the duration of the Qtc on the other (p>0.05).

Discussion:-

The duration of the QRS was an average of 97ms in our series alongside Francisco COSTA study which was 98.2ms. A left ventricular hypertrophy (LVH) was found in 25% of the cases in our series against 71% of the cases in that of CISSE. The comparison of the other data with the electronic data in the literature is shown in Table IV:

Table 4:- Comparison of electronic data with literature data.

	RSR	**AF**	**LVH**	**VE**	**SVE**	**PR**	**QRS**	**QTc**
Luis enrique bignotto [4]	93%	4,44%	36,31%	6,14%		-	-	49,1% elongated
Abe[5]	97%	3%	-	-	-	-	-	-
Cisse [6]	-	-	71,05%	-	-	-	-	-
Frederic sacher [3]	-	-	-	-	16,7%	185ms	94ms	428 ms
El oury [7]	-	1%	-	83%	-	-	-	-
Jugers p [8]	-	-	-	-	-	-	-	-
Ramazan astan[9]	-	-	-	-	-	172 ms	87,88 ms	444ms
Francisco costa [10]	-	-	37,4%	-	-	-	98,2ms	442,5 ms
Esqualli [11]	-	-	-	-	-	-	80ms	-
Our study	100%	0%	25%	62,5%	83,9%	108 ms	97ms	440ms

In our study, we found a decrease in Qtc duration, a decrease in T-wave amplitude with a statistically significant difference. We also objected to an increase in QRS duration after the hemodialysis session with a statistically significant difference compared to the Esqualli study (before dialysis: 80 ± 7.6 ms, after dialysis: 110 ± 8.0 ms, p 0.001). [11] on the other hand, we noted an increase in the prevalence of ventricular extrasystole in our series after the hemodialysis session but without it being statistically significant (p=0.1), this may be related to the absence of systolic LV dysfunction which increases the potential for ventricular hyperexcitability. Regarding biological data, it should be noted that the rapid elimination of potassium during haemodialysis, induced by a large transmembrane concentration gradient, is an over-added factor favouring the development of rhythm disorders during or immediately after the hemodialysis session [12]. A significant decrease in kaliemia has been noted in our study following the data in the literature, notably the study by Esqualli [11] which noted a significant and continuous decrease in kaliemia during the hemodialysis session (before dialysis: 6.4 ± 0.82, after dialysis: 4.21 ± 0.42 mmol/L, p 0.002) The other metabolic modifications found in our study are similar to those in the literature whose comparison is shown in Table V

Table 5:- Comparison of biological data with literature data before and after haemodialysis.

		Na+	**K+**	**Ca2+**	**Urea**	**Creatinine**
Ramazan astan [9]	**Before**	137	5,08	87,6	1,44	86
	After	135	3,58	86,8	0,53	36,2
Sayed Fareg [13]	**Before**	132	4,5	104	1,31	7

	After	135	3,4	92	0,47	9,6
P.A. Diop[14]	**Before**	-	5,1-6	-	1-3	100-200
	After	-	2,3-4,8	-	<1	40-130
Our Study	**Before**	136,2	5,6	85,4	1,2	96,6
	After	137	3,5	93,2	0,8	33,3

Conclusion:-

Knowledge of the main factors that modulate the incidence of arrhythmias in dialysis patients provides a better understanding of rhythm disorders in this population. Changes in electrolyte concentrations, such as K+ and Ca2+ in per and post-dialysis, appear to be responsible for much of the rhythm disorders in hemodialysed patients. These ionic and metabolic variations during dialysis can lead to a considerable risk of heart disease, hence the value of close monitoring in person and post dialysis.

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