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RESEARCH ARTICLE

VOLUME REPLENISHMENT BY BOLUS LIQUID INFUSION: WHATROLE IN THE ACUTE MANAGEMENT OF INTRADIALYTIC HYPOTENSION (IDH)?

Bouchoual Mohammed*[1], El Ouazzani Mouad [1], El Khand Ali [1], Anibar Sara [1], Jabrane Marouane [1], Alayoud Ahmed [2], Arrayhani Mohammed [1]

1 Department of Nephrology and Kidney Transplantation, University Hospital Souss Massa, Faculty of Medicine and Pharmacy.IbnZohr University, Agadir, Morocco.
2 Department of Nephrology and Kidney Transplantation, OUED EDDAHAB military hospital in Agadir, Faculty of Medicine and Pharmacy. IbnZohr University, Agadir, Morocco.

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Abstract

Introduction: Intradialytic hypotension (IDH) is a common complication associatedwith high morbidity and mortality in hemodialysis patients. Its management isprimarilypreventive, but if itoccurs, itrequires urgent measuresincluding volume infusion of solute to restore volemia. The objective of ourworkis to evaluate the role of bolus liquid infusion for the acute management of IDH.

Materials and Methods: This is a retrospectivestudyconductedfromJanuary 2017 to December 2021 at the hemodialysis center of the militaryhospital in Agadir involving 90 chronichemodialysis patients. Volume replenishment to treat IDH wascarried out by infusing an online bolus liquid.

Results and Discussion: Weanalyzed 30,689 sessions. IDH with or withoutsymptomswasfoundin 19.6% of cases. 14% of sessions with IDH required bolus infusion (27% of total sessions) with an average volume injected of 26315 ± 1622 ml. Factorsassociatedwith bolus administration includedadvancedage (643 ± 127 vs. 61.6 ± 12.7 years, P<0.001), femalesex (H/F ratio of 0.5 vs. 1.1, P<0.001), diabetes (47.4% vs. 44%, P<0.001), lowpre-dialyticnatremia (134 ± 14 vs. 136 ± 10 mmol/l, P<0.001), and underestimated dry weight (70.6 ± 12.5 vs. 73 ± 14.2 kg, P<0.001). Sessions with bolus infusion werecharacterized by a low total effective UF volume (2000 ± 870 ml vs. 2285.8 ± 854.8, P<0.001), shorter duration withpremature session disconnection (209 ± 25 min vs. 235 ± 7 min, P=0.02), and loweraveragedialysatetemperature (P<0.001). The final relative blood volume washigher (87 ± 9 vs. 82 ± 9, P<0.001) favoring the risk of overloadassociatedwith bolus infusion.

Conclusion: Despiteadvances in hemodialysis, IDH remains a common per-dialytic incident. Our study highlights the importance of close monitoring of hemodynamicparametersduringhemodialysis sessions to prevent IDH, actearly, and avoidliquid bolus administration associatedwith the risk of overload.

Corresponding Author:-Bouchoual Mohammed
Address:- Department of Nephrology and Kidney Transplantation, University Hospital Souss Massa, Faculty of Medicine and Pharmacy IbnZohr University, Agadir, Morocco.

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Introduction:-

Intradialytic hypotension (IDH) is a frequent complication in hemodialysis patients caused by factorsrelated to the hemodialysis session and/or the patient [1]. It can presentwithclinicalsignssuch as muscle cramps, nausea, vomiting, and malaise [2]. Thesesymptomscontribute to poortolerance of dialysis sessions, ineffective clearance, and lowerquality of life.

Intradialytic hypotension isassociatedwithincreasedmortality and significantmorbidity, notably the occurrence of cardiovascularevents such as myocardialischemia, ischemic stroke, and vascularaccessthrombosis [3, 4]. Management of Intradialytic hypotension isprimarilypreventive, but if itoccurs, itrequires urgent measures, including the infusion of physiologicalsolutes to restore volemia, althoughthis carries a risk of overload. To date, no studies have been found in the literatureconcerning the use of thisvascularfillingstrategy for managing IDH. This article aims to study the prevalence of intradialytic hypotension and itsriskfactors and to evaluate the role of bolus liquid infusion for the acute management of IDH.

Materials and Methods:-

Type and Location of Study

To studythisphenomenon, weconducted a retrospective, single-center, analyticalstudy over five yearsfromJanuary 2017 to December 2021 at the hemodialysis center of the militaryhospital in Agadir, involving 90 chronichemodialysis patients.

Study Population

Weincluded all chronic and stable hemodialysis patients over 18 yearsold. Patients in intensive care, thosewith acute renalfailure, and dialysis sessions with multiple missing data wereexcludedfrom the study.

Methods:-

Data collection wasperformed in the nephrologydepartment of the militaryhospital in Agadir fromdialysis follow-up records and the real-time dialysis session management system for patients included in the study. The Data werecollected on a specific data collection sheetcreated for thispurpose. The computer system usedis the Therapy Support Suite (TSS) by Fresenius MedicalCare; itis software thatallows monitoring of the treatment process withautomatic real-time recovery of all recordedparameters and treatmentresults on the dialysis machines. Statistical analyses wereperformedusing SPSS software. Hemodialysis sessions werecarried out using Fresenius 5008 generatorswith bicarbonate dialysate and high-permeability membranes (FX Cordiax).

Definition of Intradialytic Hypotension

In the absence of a standardizeddefinition, wedefined IDH in ourstudy as anydecrease in systolicblood pressure (SBP) ≥ 20 mmHg or a decrease in meanarterial pressure (MAP) of 10 mmHgduring the dialysis session. Regardless of the number of hypotensive episodesduring a single dialysis session, itwasconsidered a single hypotensive event, with or withoutsymptoms.

Wealsodefined IDH associatedwithvascularfilling as any SBP decrease ≥ 20 mmHg or a MAP decrease of 10 mmHgduring the dialysis session requiring bolus liquid infusion.

Measurementsweretaken in the arm opposite to the vascularaccessbefore the session, after the session, and discontinuouslyduring the session at variable intervals (pre-selectedaccording to patients) between 15 minutes and 60 minutes.

The liquidused for vascularfillingis the substitution fluidprepared online by the Fresenius 5008 dialysisgenerator. It is a sterile, pyrogen-free liquidwith the same composition as the dialysate (containing sodium, potassium, chloride, bicarbonate, glucose, acetate, magnesium, and calcium). The quantity of infusedliquidisautomaticallyrecorded by the computer system.

Results:-

Results Epidemiological Data

Weanalyzed 30,689 hemodialysis sessions concerning 90 chronichemodialysis patients with a dialysis duration of 107 months ± 76. The patients' agewas 60 years ± 14 with a sex ratio (M/F) of 0.9, and 30% of the patients had a history of ischemicheartdisease, and 70% were hypertensive and receiving antihypertensive treatment. The causal nephropathywaspredominantlydiabetes, with 48% of cases. The dry weight of our patients at inclusion was 73kg ± 12.6 with an averageinterdialyticweight gain of 1.6 kg ±1 (Figure 1).

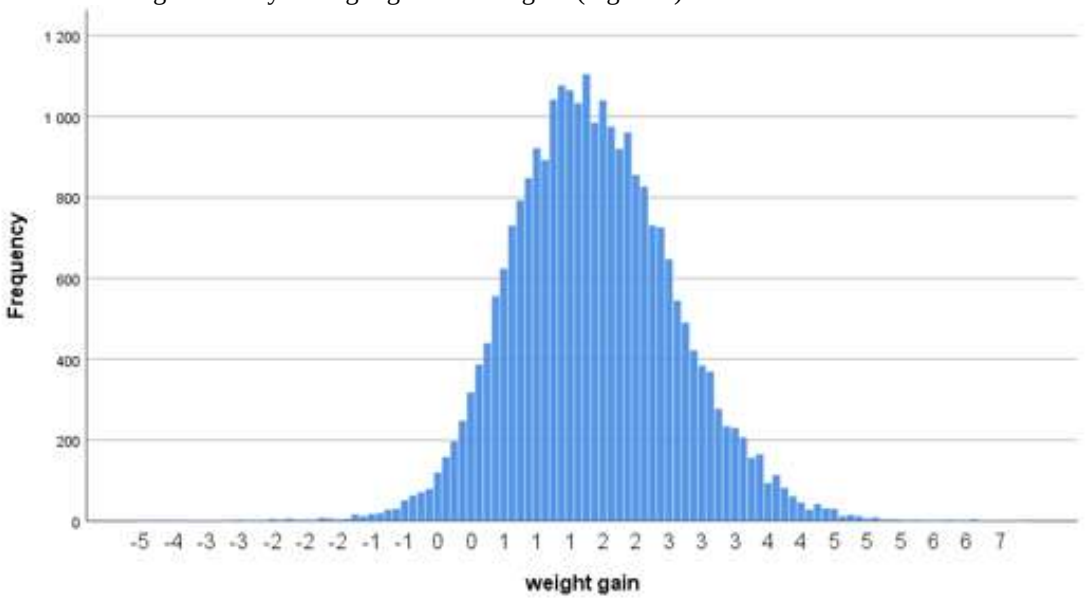

Figure 1:- Distribution of Patients According to InterdialyticWeight Gain.

Prevalence of IDH and Risk Factors

IDH with or withoutsymptomswasfoundin 19.6% of cases. 14% of sessions with IDH required bolus infusion (27% of total sessions) with an average volume injected of 26315 ± 1622 ml. This infusion allowed for a rapidincrease in volemia and symptomimprovement (Figure 2).

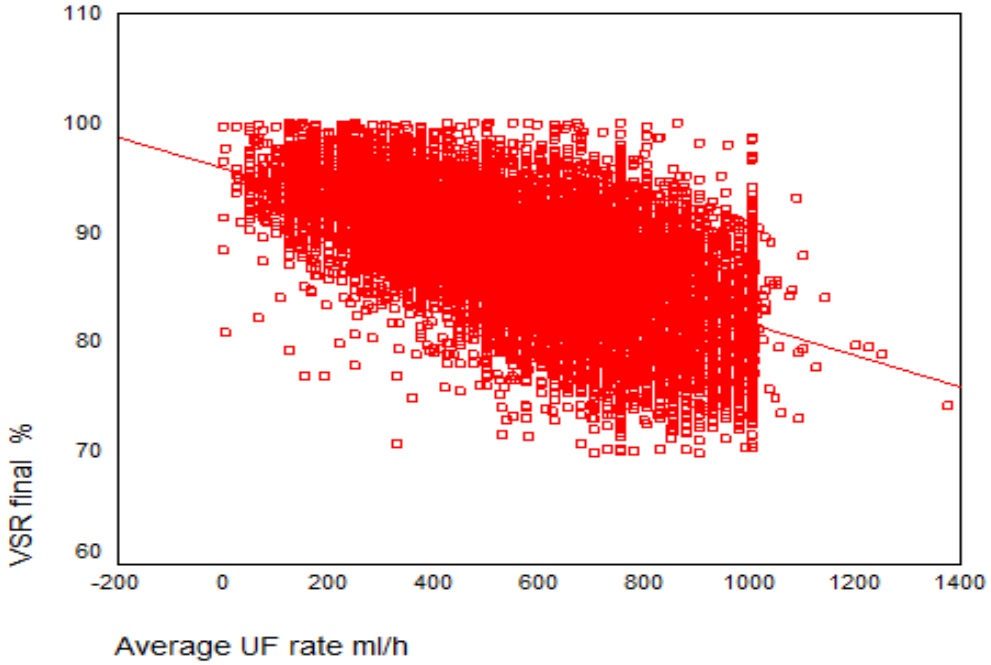

Figure 2: - CorrelationCurvebetween Final RBV and UF Rate.

Bolus administration wasassociatedwithriskfactorssuch as advancedage (P<0.001), femalesex (P<0.001), antihypertensive treatment (P<0.001), diabetes (P<0.001), low sodium gradient (P<0.001), lower dry weight (P<0.001), significant and close interdialyticweight gain (IDWG) (P=0.01), lower effective ultrafiltration (UF) rate, and higherprescribedhourly UF rate (P<0.001) (Table).

Table: - Comparison of infused and non-infused sessions.

	HID withBolus	HID withoutBolus	P value
Age (years)	64,3 ± 12,7	61.6 ± 12.7	**P<0.001**
Sex (sex ratio M/F)	0.5	1.1	**P<0.001**
Diabetes type 2	47.4%	44%	**P<0.001**
Anti-HTA treatment	54%	68%	**P<0.001**
Ischemicheartdisease	33%	32%	P=0.5
Dry weight (kg)	70.6 ± 12.5	73 ±14.2	**P<0.001**
PPID (kg)	1.5 ± 1	1.6 ±1	**P=0.01**
Total UF (ml)	2000 ± 870	2285.8 ± 854.8	**P<0.001**
Hourly ultrafiltration (ml/h)	540.2 ± 216	598 ± 212	**P<0.001**
Minimum VSR (%)	87.5 ± 5.1	87.5 ± 5	P=0.7
Final VSR (%)	82 ± 9	87 ± 9	**P<0.001**
Dialysatetemperature (°C)	36.3 ± 0.3	36.6 ± 0.3	**P<0.001**
Blood pump flow rate (ml/min)	286 ± 30	302 ± 25.5	**P<0.001**
Prescribeddialysis time (min)	240 ± 6	240,7 ± 6	P=0.9
Effective dialysis time (min)	209 ± 25	235 ± 7	**P=0.02**
Plasma sodium (mmol/l)	134 ± 14	136 ± 10	**P<0.001**
Conductivity (µS/cm)	13,94 ± 0,17	13,95 ± 0,15	NS

Sessions with IDH requiring bolus infusion werecharacterized by a low total effective UF volume, shorter duration withpremature session disconnection, lowerbloodpump flow rate, and loweraveragedialysatetemperature (P<0.001). The final relative blood volume (RBV) washigher, favoring the risk of overloadassociatedwith bolus infusion.

Discussion:-

Intra-dialytic hypotension, defined as a drop in systolic pressure below 100 mmHg, is the mostfrequent complication of chronichemodialysis. It isassociatedwith high cardiovascularmorbidity and mortality, as demonstrated in severalstudies [5]. Itsfrequency ranges from 5 to 30%, depending on the study [2].

Intradialytic hypotension isessentiallylinked to hypovolemiainduced by progressive ultrafiltration duringdialysis. However, ultrafiltration is not the only cause of thisphenomenon, as it can alsooccurduringdialysis sessions without ultrafiltration [6]. In fact, other situations can promote intra-dialytic hypotension, such as an inadequaterefilling rate [7], autonomicnervous system dysfunction [8], cardiomyopathy and vasoactive agents [9].

Vascularfillingis the cornerstone of hypovolemiatreatment. In dialysis, filling can alsobeachieved by direct infusion into the extracorporealdialysis circuit of filling solution prepared on-line by the generator.

The expectedbenefits of vascularfillingincludeincreasedvenous return, increasedsystolicejection volume, increasedarterial pressure (systolic, mean and pulsed), and increasedoxygendelivery to tissues. This benefit is judged by the regression of clinicalsigns of hypovolemia and improvement in tissue perfusion [10]. However, volume rechargingincreases the risk of overload, cerebraledema and hypothermia.

In the absence of work in the literature, ourstudyshowedthat the epidemiologicalriskfactorsassociatedwithboth HID and the use of bolus infusion are similar, namely: age, gender, diabetes, ischemicheartdisease, antihypertensive treatment [11].

In terms of dialyticparameters, sessions with HID requiring bolus infusion werecharacterized by lower dry weightwith a higherprescribedhourly ultrafiltration rate. The amount of interstitialfluidavailable for

vascularfillingisinfluenced by the patient'sdefined dry weight. Wheninterstitialfluid volume islow, any volume of ultrafiltrateis more likely to beassociatedwithhemodynamicinstability [12]. This explains the development of hypotension when patients have toolow a dry weight, as is the case in ourstudy [13].

During the interdialyticperiod, excess water and sodium accumulate in the extracellularspace. Over time, in clinical practice, the variation in water and sodium balance betweentwo sessions has been equatedwithinterdialyticweight gain (IDWG), whichdirectlyreflects patient compliance withdiet and water and sodium restriction [14]. In ourstudy, wefoundthat a high PPID was a risk factor for IDH, in line with the literature.

Relative blood volume, in the context of interdialyticblood volume measurements, refers to the ratio betweencurrentblood volume and initial blood volume at the start of treatment [15]. In ourstudy, sessions requiringvascularfillingwerecharacterized by a higher relative blood volume at the end of the session, whichis the result of fluidfilling by bolus with volume expansion. This fillingrapidlyincreases and restores blood volume, but carries a risk of hydro-sodium overload in the interdialyticinterval.

Effective dialysis time and bloodpump output directly influence dialysisquality. In ourwork, dialysis sessions with bolus infusion for HID management werecharacterized by lowbloodpump output and premature patient disconnection. Hence the importance of preventingthis HID in order to deliver an adequate dose of dialysisnecessary to improve the quality of life and survival of the dialysis patient.

Management of interdialytic hypotension isprimarilypreventive. It isbased on clinicalassessment and physical exploration of the patient'shydrationstatus, measurement of blood pressure and heart rate, modification of lifestyle and dietary habits, optimization of dry weight and ultrafiltration, and modification of dialysate composition. Thesemeasuresmakeit possible to prevent HID, actearly and avoid the administration of bolus fluids, which can lead to hydro-sodium overload.

Conclusion:-

Despiteadvances in hemodialysis, intradialytic hypotension (IDH) is a particularlywidespreadphenomenon in the elderlygeneral population, and has been the subject of severalstudies in the literature, leading to recommendations for diagnosis and management.

The prevention of IHD episodesis crucial to providing patients with optimal dialysistreatment. This is relevant not only for reducingmorbidity and mortality, but also for improvingquality of life.

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