

Intradijalizna hipotenzija i učestalost akutne fibrilacije atrijske u bolesnika na kroničnoj hemodijalizi

Intra-dialytic hypotension and frequency of acute atrial fibrillation in patients on chronic hemodialysis

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SAŽETAK: Intradijalizna hipotenzija (IDH) jedan je od najvećih problema liječenja kroničnom hemodijalizom (KH), a posebno je osjetljiva u bolesnika starije životne dobi i u onih s kardiovaskularnim poremećajima. Akutna, epizodična, IDH registrirana je u prosjeku u četvrtine svih dijaliznih tretmana, a kronična ili trajna arterijska hipotenzija obično postoji u oko 5 % bolesnika na KH-u. Istraživanje je provedeno na uzorku od 96 bolesnika u Centru za hemodijalizu Živinice. Analiza 12-kanalnog elektrokardiograma u bolesnika s IDH-om pokazala je da je 46,5 % bolesnika imalo akutnu fibrilaciju atrijske (AFA). AFA se češće pojavljivala u bolesnika ženskog spola. U sklopu IDH-a 16,6 % bolesnika, uz AFA, imalo je i ishemijske promjene na EKG-u. U bolesnika koji nisu imali AFA zabilježen je samo jedan slučaj ishemije. Pogreške u podcijenjenoj suhoj tjelesnoj težini u rasponu 0,5 – 1 kg imaju za posljednicu IDH te su često udružene s pojavom AFA tijekom hemodijalize.

SUMMARY: Intra-dialytic hypotension (IDH) is one of the biggest problems in chronic hemodialysis (CH) treatment. The incidence is especially high in elderly patients as well as in patients with cardiovascular disorders. Acute episodic IDH is registered in a quarter of all dialysis treatments on average while chronic or recurrent arterial hypotension usually occurs in about 5% of CH patients. The research study was conducted on a sample of 96 patients at the Hemodialysis Centre in Živinice. The analysis of a 12-lead electrocardiogram in patients with intra-dialytic hypotension indicated that 46.5% of patients had acute atrial fibrillation (AAF). AAF occurred more often in female patients. As part of IDH, 16.6% of patients with AAF also had ischemic changes on the ECG. In patients who did not have AAF, only one case of ischemia was recorded. Errors in underestimated dry body weight in the range of 0.5-1 kg result in IDH and are often associated with the occurrence of AAF during hemodialysis.

KLJUČNE RIJEČI: hipotenzija, fibrilacija atrijske, hemodijaliza.

KEYWORDS: hypotension, atrial fibrillation, hemodialysis.

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Hipotenzija tijekom kronične hemodijalize

Intradijalizna hipotenzija (IDH) jedan je od najvećih problema liječenja kroničnom hemodijalizom (KH), a posebno je osjetljiva u bolesnika starije životne dobi i u onih s kardiovaskularnim poremećajima. IDH je komplikacija KH-a koja ometa bolesnikovu udobnost i skraćuje vrijeme liječenja KH-om¹. Iako je IDH jedna od najčešćih komplikacija liječenja KH-om, podatci o njezinoj učestalosti znatno se razlikuju. Procjenjuje se da je u Americi IDH prisutna u četvrtine svih dijaliziranih bolesnika, dok je u Francuskoj taj broj nešto manji i iznosi 19 %².

Hypotension during chronic hemodialysis

Intra-dialytic hypotension (IDH) is one of the biggest problems of chronic hemodialysis (CH) treatment. The incidence is especially high in elderly patients and patients with cardiovascular disorders. IDH is a complication of CH that decreases patient comfort and leads to shortening of treatment time¹. Although IDH is one of the most common complications of CH, data on its frequency vary significantly. It is estimated that IDH is present in 25% of all dialysis patients in the US. The percentage is somewhat lower in France with 19%².

Hipotenzija u bolesnika na hemodijalizi može biti akutna ili kronična. Akutna, epizodična, IDH registrirana je otprilike u četvrtine svih liječenih KH-om, a određene skupine bolesnika posebno su osjetljive na ovu komplikaciju. Kronična ili trajna arterijska hipotenzija obično postoji u oko 5% bolesnika na KH-u i češća je u bolesnika koji su dulje (obično više od 5 godina) u programu KH. Takvi bolesnici u centar za hemodijalizu dolaze sa sistoličkim tlakom nižim od 90 ili 100 mmHg. Kronična IDH može pogoršati opće stanje bolesnika, odnosno ionako niske vrijedosti arterijskoga tlaka (AT) mogu naglo pasti na još niže vrijednosti.

U liječenju KH-om u kojem se ne uklanja samo tekućina (izovolemična dijaliza), hipotenzija je vrlo rijetka. Prva asocijacija na IDH jest uklanjanje viška tekućine iz organizma. Normalni je volumen plazme 40 mL/kg tjelesne težine, što je oko 2,8 litara. Od te količine, sadržaj vode u plazmi je oko 2,5 litara, a preostali su dio stanice i otopljene tvari. Iako se tijekom hemodijalize ultrafiltracijom u 4 – 5 sati odstranjuje 2 – 5 litara, istraživanja pokazuju da se volumen plazme bolesnike na kraju postupka smanjuje za samo 10 – 25 %³.

Uremički toksini koji se nakupljaju u bolesnikovu tijelu, zbog zatajenja bubrega, također utječu na hemodinamsku stabilnost bolesnika, jer imaju sposobnost da poput suhe tvari osmotski privlače vodu. Od trenutka početka KH-a dolazi do naglog uklanjanja tvari koje imaju pozitivnu ulogu u održavanju intravaskularnog volumena. Smanjenje osmolalnosti plazme odmah pogoduje prelasku izvanstanične u unutarstaničnu tekućinu, dok su povišene razine dušikova oksida registrirane u bolesnika sklonih IDH-u⁴. IDH, kao najčešća komplikacija KH-a, može se brzo izliječiti uobičajenim terapijskim postupcima, no pokatkad se ta komplikacija može dodatno zakomplicirati. Komplikacije su IDH-a brojne, a klinički su najhitnije promjene koje se mogu dogoditi na srcu i mozgu⁵.

U svakoj hipotenzivnoj epizodi pojavljuju se manje ili više izražena hipoksemija i asfiksija stanica, bilo da je riječ o stanicama srca ili mozga. U vezi s liječenjem KH-om potrebno je točno odrediti optimalnu suhu tjelesnu težinu (STT; tjelesna masa na kraju KH-a, pri kojoj se u bolesnika nisu razvili simptomi hipotenzije ili hipertenzije te nema otekline potkoljenica, ni interdijalitičke komplikacije), pravilno odabrati dijalizni set, prilagoditi temperaturu i sastav tekućine za dijalizu, propisati odgovarajuću dozu i vrstu hemodijaliznog liječenja, primijeniti intradijaliznu *online* kontrolu ultrafiltracije, prema praćenim vrijednostima AT-a, volumena krvi i temperature. Svrha je toga smanjiti brzinu UF-a kako bi bolesnik s pomoću vlastitih kompenzacijskih mehanizama lakše podnio preuranjenu ultrafiltraciju⁶. Hemodinamska nestabilnost tijekom KH-a rezultira ishemijom/reperfuzijom miokarda i mozga. Ponovljene epizode miokardne i cerebralne ishemije i reperfuzije rezultiraju omamljivanjem miokarda⁷. Omamljivanje miokarda uzrokuje poremećaj regionalne pokretljivosti stijenke lijeve klijetke i razvoj sistoličkog zatajivanja srca, a oštećenje mozga uzrokuje poremećaj kognicije. Prevencija intradijalizne hipotenzije treba uključivati ograničenje unosa soli, interdijalizni prinos u bolesnika s težinom manjom od 5 %, brzinu ultrafiltracije manju od 10 mL/kg/h, prilagodbu koncentracije natrija i kalcija u otopini, hladnu otopinu za KH (35 – 37 °C), primjenu vazopresora, hemodijafiltraciju i nove modalitete dijalize temeljene na *biofeedback* sustavima. Očuvanje hemodinamske stabilnosti bolesnika tijekom KH-a primarni je cilj⁸.

Hypotension in hemodialysis patients can be acute or chronic. Acute episodic IDH is registered in approximately one quarter of all CH treatments and certain groups of patients are particularly sensitive to this complication. Chronic or recurrent hypotension usually appears in about 5% of CH patients and is more common in patients who have undergone treatment over longer periods (usually, more than 5 years). Such patients are registered at the hemodialysis centre with a systolic blood pressure lower than 90 or 100 mmHg. Due to chronic IDH, the patient's general condition may deteriorate, i.e. already low values of blood pressure (BP) can suddenly drop to even lower values.

In CH treatment, which removes more than just fluid (isovolemic dialysis), hypotension is very rare. The first association with IDH is the removal of excess fluid from the body. The normal volume of plasma is 40 ml/kg of body weight, or about 2.8 L. Of that amount, the water content in the plasma is about 2.5 L, and the remaining part is cells and dissolved substances. Although 2-5 L are removed during hemodialysis by ultrafiltration that takes app. 4-5 hours, the research shows that the patient's plasma volume is reduced only by 10-25% at the end of the procedure³.

Due to kidney failure, uremic toxins that accumulate in the body also affect the hemodynamic stability of the patient because they have the ability to osmotically attract water like a dry substance. As soon as CH treatment starts, substances that have a positive role in maintaining the intravascular volume are removed abruptly. A decrease in plasma osmolality advances the shift of water from the extracellular to intracellular fluid. The increased levels of nitric oxide are registered in patients prone to IDH⁴. As the most common complication of CH, IDH can be quickly cured by usual therapeutic procedures, but sometimes it can lead to further complications. The complications of IDH are many. Clinically, the most urgent are the changes that may occur in the heart or brain⁵.

Every hypotensive episode also implies a more or less pronounced hypoxemia and asphyxia of heart or brain cells. In a patient with CH, it is necessary to accurately determine the optimal dry body weight (DBW; body mass at the end of CH, at which the patient has not developed symptoms of hypo- or hypertension, does not have leg swelling, or inter-dialytic complications), correctly choose the dialysis set, adjust the temperature and the composition of the dialysis fluid, prescribe the appropriate dose and type of hemodialysis treatment, and apply intra-dialysis on-line control of ultrafiltration according to the monitored values of AT, blood volume and temperature. The objective is to reduce the UF rate so that the patient can use compensatory mechanisms to tolerate premature ultrafiltration more easily⁶. Hemodynamic instability during CH results in myocardial and brain ischemia/reperfusion. Recurrent episodes of myocardial and cerebral ischemia and reperfusion result in myocardial stunning⁷. Myocardial stunning disturbs the regional mobility of the left ventricular wall and can lead to systolic heart failure while brain damage causes disturbed cognition. Prevention of IDH should include restriction of salt intake, inter-dialytic weight gain in patients with weight less than 5%, ultrafiltration rate less than 10 ml/kg/h, adjustment of sodium and calcium concentration in the solution, cold solution for CH (35-37 °C), use of vasopressors, hemodiafiltration and new dialysis modalities based on *biofeedback* systems. Preservation of hemodynamic stability of the patient during CH is the primary goal⁸.

Akutna fibrilacija atrijsa

Poremećaji srčanog ritma, osobito akutna fibrilacija atrijsa (AFA), pojavljuju se u 7 – 27 % svih bolesnika i učestaliji su tijekom duljeg razdoblja liječenja KH-om. AFA može uzrokovati hemodinamske promjene i ishemiju miokarda, što dovodi do nepovoljne prognoze. Razvoj AFA u bolesnika na KH-u povezan je s lošijim preživljavanjem i potrebom za duljim bolničkim liječenjem. Ako se podcijeni odgovarajuća STT i ultrafiltracija, dolazi do još većega sniženja sistoličkog i dijastoličkog tlaka te do pojave hipotenzije. Pad AT-a uzrokuje smanjenje protoka krvi kroz valvule i poremećaj u provodnom sustavu srca, što može dovesti do pojave AFA⁹. Većina bolesnika s navršenih 5 godina liječenja KH-om ima srednje do teško opterećenje krvožilnog sustava. Remodeliranje srca dominantna je manifestacija i može mehanički pridonijeti hemodinamskoj nestabilnosti. Štoviše, remodeliranje srca može aktivno pridonijeti razvoju komplikacija tijekom KH-a, poglavito IDH. U bolesnika na KH-u pojavljuje se kombinacija preopterećenja volumenom (retencija tekućine, prisutnost arterijsko-venske fistule, anemija) i preopterećenja tlakom (Slika 1)¹⁰.

Ciljevi ovog istraživanja bili su: odrediti učestalost AFA u slučajevima IDH te upozoriti na važnost pravilno utvrđene STT u bolesnika na programu KH.

Acute atrial fibrillation

Heart rhythm disorders, especially acute atrial fibrillation (AAF), occur in 7-27% of all patients and are more frequent in patients undergoing the CH treatment over a longer period of time. AFA can cause hemodynamic changes and myocardial ischemia, which leads to an unfavorable prognosis. The development of AAF in patients on CH is associated with worse survival outcomes and the need for longer hospital treatment. If the appropriate dry body weight and ultrafiltration are underestimated, there is an even greater decrease in systolic and diastolic pressure and the occurrence of hypotension. A drop in BP leads to a decrease in blood flow through the valves and disturbances in the conduction system of the heart, which can lead to AAF⁹. The majority of patients who have completed 5 years of CH treatment have a moderate to severe burden on the circulatory system. Cardiac remodelling is the dominant manifestation and may mechanically contribute to hemodynamic instability. Moreover, cardiac remodelling may actively contribute to the development of complications during CH, and, most importantly, to IDH. In the patients on CH, a combination of volume overload (fluid retention, presence of arteriovenous fistula, anemia) and pressure overload occur (Figure 1)¹⁰.

The objectives of this research were to determine the frequency of AAF in cases of IDH and to emphasize the importance of correctly determined dry body weight in patients on CH.

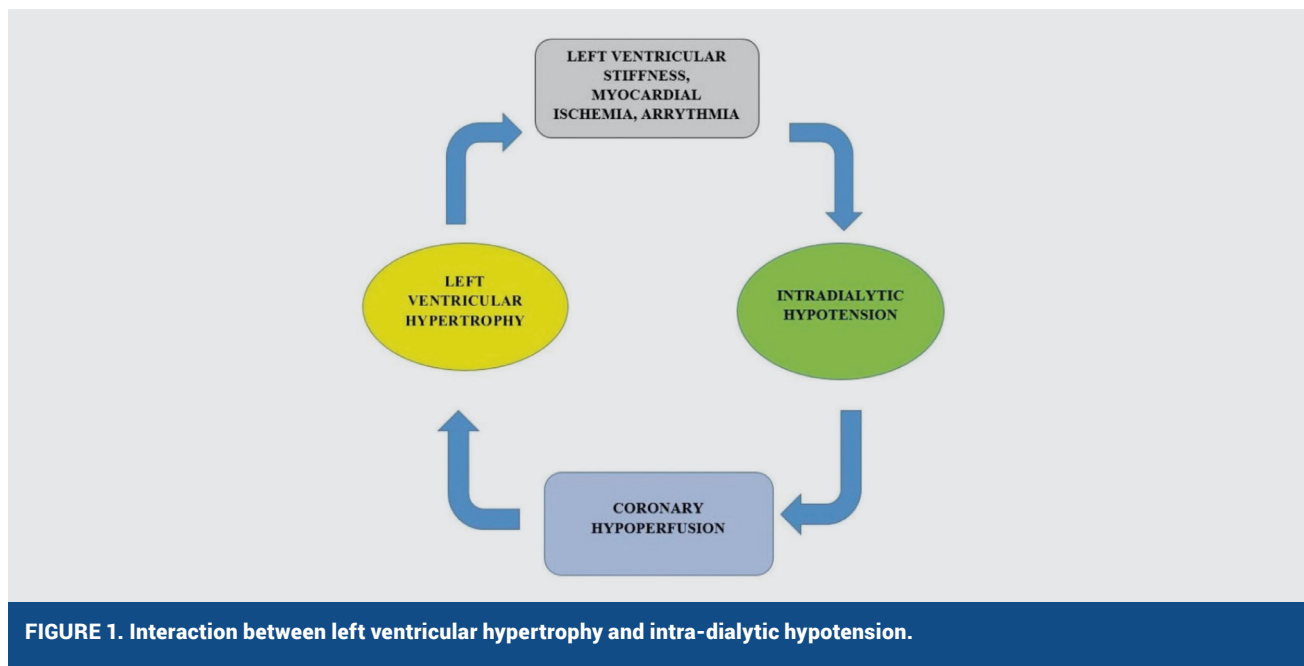


FIGURE 1. Interaction between left ventricular hypertrophy and intra-dialytic hypotension.

Bolesnici i metode

U Centru za hemodijalizu Doma zdravlja Živinice od 1. svibnja 2021. do 31. ožujka 2022. provedeno je randomizirano istraživanje kojim je ispitivana učestalost IDH-a i AFA u bolesnika na KH-u. Ukupan broj dijaliziranih bolesnika u spomenutom je razdoblju bio 125, a u istraživanje je uključeno 96 bolesnika. Ostalih 29 bolesnika nije uključeno u istraživanje jer su imali

Patients and Methods

At the Hemodialysis Centre in Živinice Health Centre, a randomized study was conducted in the period May 1, 2021 - March 31, 2022, which examined the frequency of IDH and AAF in patients on CH. The total number of dialysis patients in that period was 125, out of which 96 were included in the study. The remaining 29 patients were not included in the study as they

druge pridružene bolesti poput dijabetesa, komplikacija bolesti COVID-19 te demenciju. Svi bolesnici uključeni u istraživanje bili su stariji od 18 godina, a bili su na programu KH-a triput tjedno.

Bolesnici su bili podijeljeni u četiri skupine prema spolu i pojavnosti IDH-a ili normotenzivnosti:

- skupina I. uključila je 20 muškaraca s IDH-om
- skupina II. uključila je 26 žena s IDH-om
- skupina III. uključila je 23 muškarca koji su bili normotenzivni tijekom KH-a
- skupina IV. uključila je 27 žena koji su bili normotenzivni tijekom KH-a.

U svih uključenih bolesnika učinjen je 12-kanalni elektrokardiogram (EKG) u zadnjem satu trajanja KH-a, jedanput tjedno. Bolesnicima koji su imali simptome / kliničke znakove aritmije srca ili anginozne boli EKG je načinjen odmah nakon pojave simptoma / kliničkih znakova. U svih su bolesnika na EKG-u praćeni znakovi ishemijske (promjene elevacije i depresije na ST-segmentu i T-valu), bez obzira na prisutnost kliničkih znakova / simptoma akutnoga koronarnog sindroma.

Svi su podatci obrađeni metodama deskriptivne statistike, pri čemu su broječni podatci prikazani odgovarajućim mjerama središnje tendencije i mjerama varijance, te su prikazani odgovarajućim tablicama i slikama. Za izračunavanje statističke značajnosti primjenjivane su neparametarske metode i testovi: χ^2 test rabljen je za izračunavanje razlika unutar skupina, a Kruskal-Wallisov test služio je za izračunavanje razlika između grupa uz χ^2 test, a, ako je postojala statistički značajna razlika između skupina, provedeno je testiranje između skupina s pomoću Mann-Whitneyjeva U-testa. Za parametarske podatke izračunate su razlike između skupina primjenom jednosmjerne analize varijance (ANOVA), s naknadnim izračunom Tukeyjeva HD testa ako su postojale razlike među skupinama, a Studentov „t“-test primijenjen je za zavisne uzorke. Statističke su hipoteze testirane na razini $\alpha = 0,05$, odnosno razlika između skupina u uzorku smatrana je značajnom ako je $p < 0,05$. Statistička obrada obavljena je uz podršku biomedicinskog aplikativnog softvera „MedCalc za Windows verzija 12.4.0“, Copyright © 1993-2013 i softverom „SPSS Statistics 17.0“, Copyright © 1993-2007.

Rezultati

U ispitivanje je bilo uključeno 96 ispitanika, od toga 43 muškarca i 53 žene. Ova razlika u učestalosti muških i ženskih ispitanika statistički je značajna u korist ženskih ispitanika ($\chi^2 = 11,025$; $df = 1$; $p = 0,001$).

Analiza EKG nalaza u bolesnika s IDH pokazala je da je 46,5 % bolesnika imalo AFA. Uočene razlike su statistički značajne ($\chi^2 = 3,974$; $df = 3$; $p = 0,26$). U sklopu IDH-a 16,6 % bolesnika uz AFA-om imalo je i ishemijske promjene na EKG-u. Prema Kruskal-Wallisovu testu, ova je razlika statistički značajna ($\chi^2 = 30,869$; $df = 9$; $p < 0,001$). U bolesnika koji nisu imali AFA, tijekom istraživanja zabilježen je samo jedan slučaj ishemijske na EKG-u, što je statistički značajno ($\chi^2 = 0,775$; $df = 4$; $p = 0,001$). U sklopu IDH-a 16,6 % bolesnika uz AFA imalo je i ishemijske promjene na EKG-u. Prema Kruskal-Wallisovu testu, ova je razlika statistički značajna ($\chi^2 = 17,6$; $df = 3$; $p = 0,001$) (**Tablica 1**).

had other associated diseases, such as diabetes, complications related to COVID-19 and dementia. All patients included in the study were older than 18 years and on CH treatment three times a week.

The patients were divided into four groups according to gender and incidence of IDH or normotensivity:

- Group 1 included 20 men with IDH
- Group 2 included 26 women with IDH
- Group 3 included 23 men who were normotensive during CH
- Group 4 included 27 women who were normotensive during CH.

A 12-lead electrocardiogram (ECG) was performed on all patients included in the study during the last hour of CH, once a week. Patients who had symptoms/clinical signs of cardiac arrhythmia or anginal pain had an ECG performed immediately after the onset of symptoms/clinical signs. All patients were monitored for signs of ischemia on the ECG (changes in elevation and depression on the ST-segment and T wave), regardless of the presence of clinical signs/symptoms of acute coronary syndrome.

All data were processed using the methods of descriptive statistics. The numerical data are presented as appropriate measures of central tendency and variance and displayed in appropriate tables and figures. Non-parametric methods and tests were used to calculate statistical significance. The χ^2 test was used to calculate the differences within the groups while the Kruskal-Wallis test was used to calculate the differences between the groups. In case there is a statistically significant difference between the groups, the Mann-Whitney U test was used as an additional testing tool. For parametric data, the differences between the groups were calculated using a one-way analysis of variance (ANOVA), with post-hoc Tukey's HSD test in case there were differences between the groups. Student's t test was used for dependent samples. Statistical hypotheses were tested at the $\alpha = 0.05$ level, that is, the difference between the groups in the sample was considered significant if $p < 0,05$. Statistical processing was performed with the support of the biomedical application software "MedCalc for Windows version 12.4.0", Copyright © 1993-2013 and "SPSS Statistics 17.0", Copyright © 1993-2007.

Results

A total of 96 subjects were included in the study, of which 43 were men and 53 were women. This difference in the frequency of male and female respondents is statistically significant in favour of female respondents ($\chi^2 = 11.025$; $df=1$; $p=0,001$).

The analysis of ECG recordings in patients with IDH indicated that 46.5% of patients had AAF. The observed differences are statistically significant ($\chi^2 = 3.974$; $df = 3$; $p = 0,26$). As part of IDH, 16.6% of patients with AAF also had ischemic changes on the ECG. According to the Kruskal-Wallis test, this difference is statistically significant ($\chi^2 = 30,869$; $df=9$; $p<0,001$). In patients who did not have AAF, only one case of ischemia was recorded on the ECG during the study, which is statistically significant ($\chi^2 = 0.775$; $df = 4$; $p = 0,001$). As part of IDH, 16.6% of patients with AAF also had ischemic changes on the ECG. According to the Kruskal-Wallis test, the difference is statistically significant ($\chi^2 = 17.6$; $df = 3$; $p = 0,001$) (**Table 1**).

TABLE 1. Incidence of atrial fibrillation.

	ECG			
	Mean systolic pressure	Mean diastolic pressure	Incidence of atrial fibrillation	Frequency of ischemia
Male patients with intra-dialytic hypotension	90	59	12	2
Female patients with intra-dialytic hypotension	85	57	13	1
Male normotensive patients	128	83	3	0
Female normotensive patients	125	81	2	0
Total			30	3

($\chi^2= 30,869$; $df=9$; $p<0,001$)

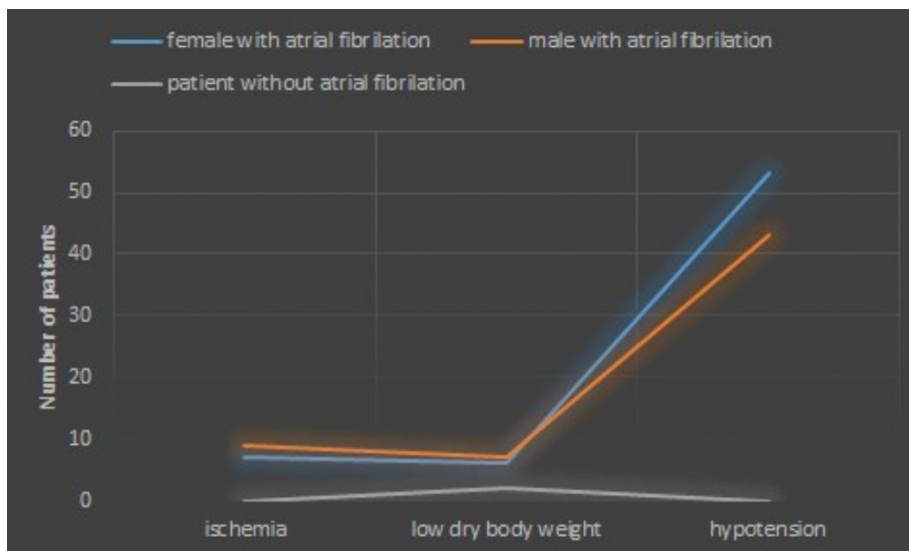


FIGURE 2. Ischemic changes associated with intra-dialytic hypotension.

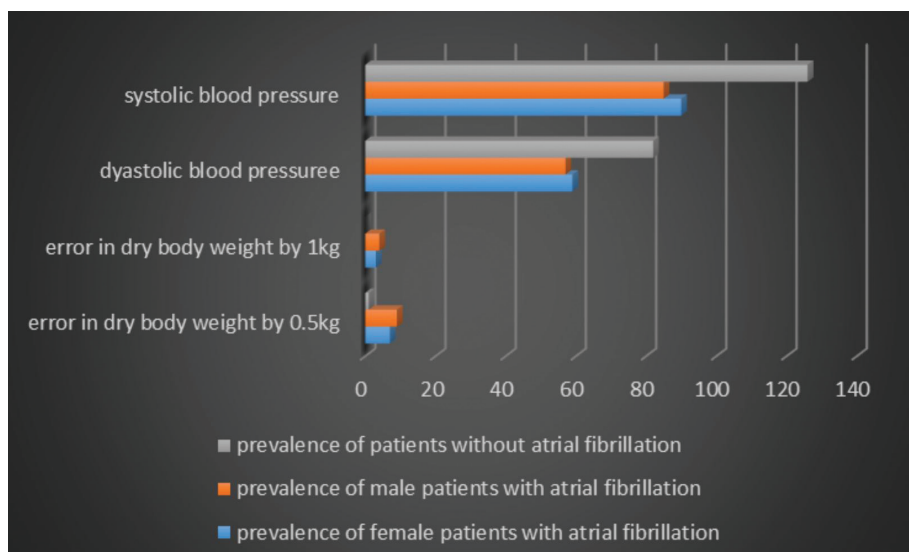


FIGURE 3. Dry body weight and frequency of atrial fibrillation.

U bolesnika koji nisu imali AFA kao poremećaj ritma, tijekom istraživanja zabilježen je samo jedan slučaj ishemije na EKG-u, što je statistički značajno ($\chi^2 = 0,775$; $df = 4$; $p = 0,001$) (Slika 2).

Pogreške u podcijenjenoj STT u rasponu 0,5 – 1 kg imaju za posljedicu IDH te su često udružene s pojavom AFA tijekom hemodijalize, što se vidi na Slici 2. Kruskal-Wallisovim testom podcijenjena vrijednost STT-a u bolesnika ima statističku značajnost ($\chi^2 = 1,813$; $df = 2$; $p = 0,4$) (Slika 3).

Pri prijemu bolesnika srednja vrijednost sistoličkog tlaka iznosila je 107 mmHg, dok je vrijednost dijastoličkog tlaka bila 83 mmHg. Testiranjem korelacije između sistoličkog i dijastoličkog tlaka utvrđeno je da postoji jednosmjerna korelacija (Tablica 2) (Pearsonov $r = 0,136$; $p = 0,043$).

In patients who did not have AAF as a rhythm disorder, only one case of ischemia was recorded on the ECG during the study, which is statistically significant ($\chi^2 = 0.775$; $df = 4$; $p = 0,001$) (Figure 2).

Errors in the underestimated dry body weight in the range of 0.5 - 1 kg result in IDH, and are often associated with the occurrence of AAF during haemodialysis, which can be seen in Figure 2. The Kruskal-Wallis test indicated that the underestimated value of dry body weight in patients has statistical significance ($\chi^2 = 1.813$; $df = 2$; $p = 0,4$) (Figure 3).

At the time of admission, the mean value of systolic pressure was 107 mmHg, and the value of diastolic pressure was 83 mmHg. By testing the correlation between systolic and diastolic pressure, a one-way correlation was determined (Table 2) (Pearson's $r = 0.136$; $p = 0,043$).

TABLE 2. Differences between groups in the observed blood pressure.

	Mann-Whitney U	Significance
Male patients with intra-dialytic hypotension	Z = -4.92	p<0.001
Female patients with intra-dialytic hypotension	Z = -2.88	p=0.004
Normotensive male and female patients	Z = -3.79	p<0.001

F (3,156) = 106.034; p<0.001; eta-squared= 0.67 (systolic blood pressure)
 F (3,156) = 55.434; p<0.001; eta-squared= 0.51 (diastolic blood pressure)

Rasprava

Ovo istraživanje pokazuje da su niže vrijednosti sistoličkoga i dijastoličkoga tlaka povezane s pojavom AFA u bolesnika na KH-u. U bolesnika koje su na programu KH i imaju IDH utvrđene se nešto niže vrijednosti sistoličkog i dijastoličkog tlaka, za razliku od muških bolesnika. To je u suprotnosti s nalazima koji upućuju na povezanost AT-a i AFA u općoj populaciji. U studiji na 4,3 milijuna odraslih osoba u Ujedinjenom Kraljevstvu, svaki 20 mmHg viši sistolički tlak bio je povezan s višim rizikom od slučajne AFA, kao i svaki dijastolički tlak 10 mmHg viši od normalnog¹¹. Ova općenito linearna povezanost sistoličkoga i dijastoličkoga tlaka opažena je u osoba u dobi od 30 do 60 godina, ali je bila mnogo manja u bolesnika starijih od 60 godina. Slični nalazi o pozitivnoj povezanosti između AT-a i životne dobi od AFA u općoj populaciji zabilježeni su u longitudinalnom istraživanju primjenom podataka iz Framinghamske studije¹¹.

U istraživanju koje je proveo Chang, među 17 003 bolesnika u njih 3785 razvila se AFA. Niži sistolički tlak prije dijalize bio je povezan s većim rizikom od AFA, dok je viši sistolički tlak bio povezan s manjim rizikom od AFA. Svakih 10 mmHg nižega sistoličkoga tlaka od normalne vrijednosti povezano je s opasnošću od nastanka AFA. Niži dijastolički tlak bio je povezan s većim rizikom od AFA¹².

U spomenutom istraživanju veći broj slučajeva AFA i ishemije miokarda tijekom hemodijalize također je uočen u bo-

Discussion

This research study shows that lower values of systolic and diastolic blood pressure are associated with the occurrence of AAF in CH patients. In female patients on CH with IDH, slightly lower values of systolic and diastolic pressure were found, in contrast to male patients. This is at variance with the findings indicating the correlation between BP and AAF in the general population. In a study covering 4.3 million adults in the United Kingdom, each increase of 20 mmHg in the systolic pressure was associated with a higher risk of incident AAF, as was the case with each increase in diastolic pressure of 10 mmHg that is higher than the normal¹¹. This, generally linear, relationship between systolic and diastolic blood pressure was observed among subjects aged 30 to 60 years, but was much less pronounced in patients over 60 years of age. Similar findings indicating a positive correlation between BP and AAF life expectancy in the general population were reported in a longitudinal study using data from the Framingham Study¹¹.

In the study conducted by Chang, in the group comprising 17,003 patients, 3,785 developed AAF. Lower systolic pressure before dialysis was associated with a higher risk of AAF, while higher systolic pressure was associated with a lower risk of AAF. Every decrease of 10 mmHg in comparison with the normal systolic blood pressure was associated with the risk of developing AAF. Lower diastolic pressure was associated with a higher risk of AAF¹².

lesnika koji su imali IDH, češće u ispitanika ženskoga spola. Moguće objašnjenje za nedosljednosti između istraživanja u bolesnika na KH-u u usporedbi s drugim može biti da pacijenti s nižim AT-om prije dijalize mogu imati poteškoća s adekvatnom ultrafiltracijom i postizanjem postdijalizne izvanstanične euvolemije¹³. Zauzvrat, preopterećenje volumenom može dovesti do veće veličine atrija i povećanja tlaka u plućnoj arteriji, što je povezano s AFA-om u bolesnika koji nisu na hemodijalizi. Štoviše, postoje određeni čimbenici rizika za AFA koji su specifični za populaciju bolesnika na KH-u, a posebno su bitne promjene u serumskim koncentracijama kalija i kalcija koje se često pojavljuju tijekom KH-a¹⁴.

U ovom je istraživanju dokazano da podcijenjeni STT u rasponu od 0,5 do 1 kg ima najvažniju ulogu u nastanku IDH-a, a posljedično i AFA. Netočna STT bila je najčešća u muških ispitanika. Normotenzivni bolesnici malokad su imali AFA i ishemiju, što u istraživanju nije bilo statistički značajno.

Intradijalizna hipotenzija i remodeliranje miokarda, osobito hipertrofija lijeve klijetke (HLK), blisko su povezani. HLK ne samo da utire put prema pojavi IDH-a nego aktivno olakšava pad AT-a tijekom KH-a, uključujući i pojavu aritmija i ishemija miokarda. Također postoje dokazi koji upućuju na to da IDH pojačava HLK, pa tu postoji začarani krug. Zaista je teško razriješiti vezu međusobno, ali jasnije razumijevanje složene interakcije između IDH-a i HLK-a može pomoći u osmišljavanju korisnih strategija za izbjegavanje pojava IDH-a i HLK-a.¹⁵

Smanjenje STT-a može uzrokovati smanjeno punjenje srca i povezano je s rizicima, uključujući IDH. Odgovarajuća STT od najveće je važnosti u prevenciji IDH-a. Istraživanje koje su proveli Sinha i sur. uključila je 269 bolesnika na KH-u, od kojih je 16 imalo smrtni ishod kardiovaskularnog podrijetla zbog podcijenjenog STT-a i naknadnih srčanih aritmija. Ovo upućuje na povezanost između STT-a i kardiovaskularnog statusa¹⁶.

Incidencija IDH-a i AFA u Japanu je 24,7 %, dok je u Belgiji 27 %. Incidencija novodijagnosticirane AFA tijekom razdoblja KH-a bila je 3,0 na 100 bolesnika u Švedskoj¹⁷. Klinička randomizirana ispitivanja pokazuju da su niži sistolički i dijastolički tlakovi povezani s većim rizicima od kardiovaskularnih događaja i smrti¹⁸. To je u skladu s ovim istraživanjem. Ovakvi nalazi ističu važnost randomiziranih istraživanja za uspostavljanje optimalnog ciljanog AT-a u bolesnika na KH-u kako bi se smanjili rizici od kardiovaskularnih događaja, uključujući AFA¹⁹.

Zaključak

Analizom četiriju skupina ispitanika istraživana je učestalost pojave AFA u sklopu IDH-a. Došlo se do nekoliko zaključaka. Pojave AFA česte su u sklopu IDH-a, osobito u bolesnika ženskoga spola. Ishemijske promjene u bolesnika na KH-u učestalije su u bolesnika koji imaju AFA. Podcijenjena STT glavni je razlog pojave IDH-a.

In this study, a higher number of cases of AAF and myocardial ischemia during hemodialysis were also observed in IDH patients, and more frequently in female subjects. A possible explanation for the inconsistencies between the studies in CH patients compared to other groups of patients may be that patients with lower BP prior to dialysis maybe had difficulties with adequate ultrafiltration and achieving post-dialysis extracellular euvoemia¹³. In turn, volume overload can lead to larger atrial size and increased pulmonary artery pressure, which is associated with AAF in non-haemodialysis patients. Moreover, there are certain risk factors related to AAF that are specific for the CH patient population, especially the changes in serum potassium and calcium concentrations that often occur during CHT¹⁴.

This study proves that an underestimated dry body weight in the range of 0.5 to 1 kg plays the most important role in the development of IDH, and consequently AAF. Incorrect dry body weight was most common in male subjects. Normotensive patients rarely had AAF and ischemia, which was not statistically significant in this study.

IDH and myocardial remodelling, especially left ventricular hypertrophy (LVH), are closely correlated. LVH not only paves the way for the occurrence of IDH, but actively facilitates the drop in BP during CH, including the occurrence of arrhythmias and myocardial ischemia. There is also evidence to suggest that IDH enhances LVH, creating a vicious circle. It is indeed difficult to explain the interrelationship, but a clearer understanding of the complex interplay between IDH and LVH may help design useful strategies to avoid the occurrence of IDH and LVH.¹⁵

A decrease in DBW can cause decreased cardiac output and is associated with a number of risks, including IDH. Adequate DBW is of utmost importance in the prevention of IDH. A study by Sinha et al. included 269 patients on CH, 16 of whom had a fatal outcome of cardiovascular origin due to underestimated DBW and subsequent cardiac arrhythmias. This indicates a correlation between DBW and cardiovascular status¹⁶.

The incidence of IDH and AAF in Japan is 24.7%, and in Belgium 27%. The incidence of newly diagnosed AAF during the CH period was 3.0 per 100 patients in Sweden¹⁷. Clinical randomized trials indicate that lower systolic and diastolic pressures are associated with higher risks of cardiovascular events and death¹⁸. This is consistent with this research. These findings emphasize the importance of randomized trials to establish the optimal target BP in CH patients in order to reduce the risks of cardiovascular events, including AAF¹⁹.

Conclusion

The frequency of occurrence of AAF as part of IDH was investigated by analyzing four groups of subjects. Several conclusions were reached. Occurrences of AAF are common in IDH, especially in female patients. Ischemic changes in CH patients are more frequent in patients with AAF. Underestimated dry body weight is the main cause of IDH.

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