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ORIGINAL ARTICLE / ОРИГИНАЛНИ РАД

The effect of hemodialysis on the ocular anterior morphometry and intraocular pressure

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SUMMARY

Introduction/Objective This study evaluates the effects of hemodialysis (HD) on intraocular pressure (IOP) and ocular anterior chamber morphometry in end-stage renal disease (ESRD) patients.

Methods In total, 32 ESRD patients (50 eyes) who were on regular HD program, underwent ocular examination. To all of them, 30 minutes before HD and 30 minutes after the end of the HD session, central corneal thickness (CCT), keratometric values (K1, K2), axial length (AL), anterior chamber depth (ACD), and lens thickness (LT) were measured using the Lenstar 900 Haag-Streit USA device (Haag-Streit Group, Köniz, Switzerland). IOP was measured using Goldman applanation tonometry.

Results IOP before HD was 15.74 ± 3,043 while after HD it was 15.14 ± 3,07 (p = 0.125); K1 and K2 values were 43.11 ± 1.68 vs. 43.13 ± 1.73 (p = 0.688) and 43.11 ± 1.60 vs. 43.11 ± 1.66 (p = 0.158); AL increase from 23.25 ± 0.68 to 23.27 ± 0.68 in postHD (p = 0.158) as well as AL from 23.25 ± 0.68 to 23.27 ± 0.68 (p = 0.264); ACD decrease insignificantly from 3.14 ± 0.40 to 3.10 ± 0.42 (p = 0.063); mean LT before HD was 4.66 ± 0.38 while after HD it was 4.67 ± 0.36 (p = 0.290) and CCT was 563.68 ± 42.02 *vs*. 563.34 ± 42.26 (p = 0.777).

Conclusion HD has no significant influences on ocular anterior segment structures such as on CCT, ACD, LT, AL, K values as well as IOP.

Keywords: hemodialysis; eye; ocular morphometry

INTRODUCTION

The end-stage renal disease (ESRD) represents the last stage of irreversible kidney disease which requires transplantation or dialysis. The main purpose of hemodialysis (HD) is to regulate the composition and volume of body fluids by removing excess water and dissolved substances such as urea, potassium, and phosphorus from the body. Consequently, after HD, there is a decrease in systemic blood pressure, plasma volume, and body weight. An increase in the colloid osmotic pressure of the plasma, caused by increased plasma protein concentration, leads to water entering the plasma through the interstitial space. These fluctuations in systemic blood pressure and metabolic parameters can result in refraction changes, dry eye, "red eye syndrome" [1], calcium accumulation in the conjunctiva, band-shaped keratopathies, intraocular pressure (IOP) fluctuations, lens opacities, increased tear osmolarity, corneal endothelium changes, central corneal thickness (CCT) alterations, and variations in the thickness of the retina and choroid in patients undergoing HD. Additionally, signs of retinopathy may manifest due to hypertension, anemia, uremia, and diabetes mellitus. Patients on HD have also shown disturbances in choroidal perfusion [2].

Various results have also been published regarding the influence of HD on the biometric parameters of the eye, such as keratometry values, CCT, anterior chamber depth (ACD), lens thickness (LT) central macular thickness, and axial eye length.

This study evaluates the effects of HD on IOP, central macular thickness, corneal morphometry, anterior chamber (AC) morphometry, and axial length (AL) in patients with cataracts and ESRD.

METHOD

Fifty eyes of 32 ESRD patients who were on regular HD (three times weekly, approximately four hours per session), and who were dialyzed at the Zvezdara University Clinical Center, Belgrade, Serbia, underwent ocular examination including slit lamp examination and ophthalmoscopy. To all of them, 30 minutes before HD and 30 minutes after the end of the HD session, IOP, CCT, keratometry values (K1, K2), AL, ACD, and LT were measured. For the measurement of the above-mentioned parameters, the Lenstar 900 Haag-Streit USA device (Haag-Streit Group, Köniz, Switzerland) was used. IOP was measured using a Goldmann applanation tonometer (Haag-Streit Group). All patients who underwent gonioscopy with narrow and closed angles were excluded from the study because angle structure could be an

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independent risk factor for IOP elevation. Statistical analysis were performed by SPSS Statistics for Windows, Version 17.0. (SPSS Inc., Chicago, IL, USA), and p values < 0.05 were considered statistically significant.

This study has been approved by the institutional Ethics Committee and patients' written consent was obtained, according to the Declaration of Helsinki (1/01/24).

RESULTS

In total, 50 eyes of 32 ESRD patients undergoing regular HD treatment, including 20 males (62.5%) and 12 females (37.5%) were enrolled in the study. The mean age of the patients was 70.03 years ± 6.2 (range 59–83 years). Among them, 22 (68.8% of all) had systemic hypertension, and six (18.8% of all) had type 2 diabetes.

There are no differences between observed parameters before and immediately after HD as shown in Table 1.

Table 1. Biometric characteristics of anterior eye segment before and after hemodialysis (HD)

Parameter	Unit	Before HD	After HD	p
Intraocular pressure	mmHg	15.74 ± 3.043	15.14 ± 3.07	0.125
K1	diopters	43.11 ± 1.68	43.13 ± 1.73	0.688
K2	diopters	43.11 ± 1.60	43.11 ± 1.66	0.158
Axial length	mm	23.25 ± 0.68	23.27 ± 0.68	0.264
Anterior chamber depth	mm	3.14 ± 0.40	3.10 ± 0.42	0.063
Lens thickness	mm	4.66 ± 0.38	4.67 ± 0.36	0.290
Corneal thickness	μm	563.68 ± 42.02	563.34 ± 42.26	0.777

K1 and K2 – keratometric values

According to the aforementioned, HD does not influence anterior segment parameters as well as macula thickness.

DISCUSSION

The majority of studies have examined the effect of HD on IOP. The results obtained are conflicting, ranging from those indicating an increase in IOP after HD, those that do not record a change in IOP values, to those suggesting a statistically significant decrease in IOP after HD [3].

The IOP remains stable, while at a narrow and especially at a closed angle, the IOP increases significantly [4]. The mechanism of IOP elevation includes an increase of colloid osmotic pressure and aqueous humor production, consequently [5]. The second mechanism includes the osmotic difference between the lens and the aqueous humor-water enters into the lens which became thicker, AC reduces depth and narrow-angle leads to a reduced outflow. The final result is an increase in IOP. Wang et al. [5] reported that IOP was significantly increased after two hours of HD in the extremely narrow-angle group and returned to pre-hemodialyzed values 30 minutes after HD.

Since HD induces dehydration and ultrafiltration, it could cause a decrease in the iris and ciliary body thickness with widening of the AC [6, 7]. Consequently, increasing aqueous humor drainage through a widely open angle can reduce IOP. Thus, many factors can increase and decrease IOP during HD [8]. In our study, IOP remains the same in the immediate post-HD period in comparison with the baseline level. The same results were reported by other authors [9, 10, 11] as well as Lim et al. [10], who also found out that the visual field improved after HD. We did not measure IOP during HD sessions as some other authors did such as Wang et al. [5] reported in their study. Recently, case with neovascular glaucoma due to proliferative diabetic retinopathy with unilateral pain in the left eye was reported. Authors concluded that limited outflow during HD in such cases indicates urgent intervention [12]. In conclusion, HD patients with narrow angles, neovascular or exfoliative glaucoma, could have a significant IOP increase at the end of HD because of the osmolar gradient between the plasma and ocular tissue.

The interest of many authors has arisen in recent years regarding the HD effect on CCT and anterior segment morphometry. Asiedu et al. [1] reported that the mean CCT decreased significantly following hemodialysis while Wang et al. [8] found out CCT significant mean decrease. Kanawa et al. [13] also reported a significant decrease in corneal thickness measured in 50 eyes after HD. In our study, CCT remains the same after HD but seems that CCT should be measured during HD session. Elbay et al. [14] found out that CCT and IOP significantly increased in the second hour of HD but at the end of the HD session, there were no significant changes in comparison with baseline.

Keratometric values remain stable after HD in our study. Similar results have been published previously [14]. Elbay et al. [14] also reported that ACD remain stable during the HD session, similar to the result of our study. However, some authors [15] found significant decrease in AC parameters. They measured AC angle parameters such as the angle opening distance (AOD) and the trabecular-iris space area (TISA) by AS-OCT to 20 HD patients. Almaznai et al. [16] reported a significant decrease in ACD and LT after HD.

Yin et al. [17] reported the same results as we did: HD had no significant effect on K readings, CCT, ACD, LT, or IOP. Some authors found that the mean AL was significantly reduced with an average value of 0.26 ± 0.15 mm while others found out that HD increased AL.

CONCLUSIONS

According to our results, HD has no significant influences on ocular anterior segment structures such as on CCT, ACD, LT, AL, K values as well as IOP. Due to possible fluctuations, according to the reliable data, it is recommended to measure the mentioned parameter during the HD session.

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Conflict of interest: None declared.

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Утицај хемодијализе на морфометрију предњег сегмента ока и интраокуларни притисак

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САЖЕТАК

Увод/Циљ Ова студија процењује ефекте хемодијализе (ХД) на интраокуларни притисак и морфометрију предњег сегмента ока код болесника у терминалној фази бубрежне инсуфицијенције.

Методе Укупно 32 болесника у терминалној фази бубрежне инсуфицијенције (50 очију) који су били на редовном програму ХД подвргнути су очном прегледу. Свима њима су 30 минута пре ХД и 30 минута после завршетка сесије ХД мерене централна дебљина рожњаче, кератометријске вредности (К1, К2), аксијална дужина, дубина предње коморе и дебљина сочива помоћу уређаја *Lenstar 900 Haag-Streit USA* (*Haag-Streit Group*, Кениц, Швајцарска). Интраокуларни притисак мерен је помоћу Голдманове апланационе тонометрије.

Резултати Интраокуларни притисак пре ХД био је 15,74 ± 3,043, док је после ХД био 15,14 ± 3,07 ($p = 0,125$); вредности К1 и К2 биле су 43,11 ± 1,68 према 43,13 ± 1,73 ($p = 0,688$) и 43,11 ± 1,60 према 43,11 ± 1,66 ($p = 0,158$); аксијална дужина се повећала са 23,25 ± 0,68 на 23,27 ± 0,68 у постХД ($p = 0,158$), као и аксијална дужина са 23,25 ± 0,68 на 23,27 ± 0,68 ($p = 0,264$); безначајно се смањила дубина предње коморе – са 3,14 ± 0,40 на 3,10 ± 0,42 ($p = 0,063$); средња дебљина сочива пре ХД била је 4,66 ± 0,38, док је после ХД била 4,67 ± 0,36 ($p = 0,290$), а централна дебљина рожњаче је била 563,68 ± 42,02 наспрам 563,34 ± 42,26 ($p = 0,777$).

Закључак ХД нема значајних утицаја на структуре предњег очног сегмента као што су вредности централне дебљине рожњаче, дубина предње коморе, дебљина сочива, аксијална дужина, кератометријске вредности, као и интраокуларни притисак.

Кључне речи: хемодијализа; око; окуларна морфометрија