Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 4, 2021, Pages. 9137 - 9147
Received 05 March 2021; Accepted 01 April 2021.

The Role of the Hormone Hepcidinand Some Biochemical Variables in Patients with Kidney Stones

Yasir K. Khalil Ibrahim[1a] ,Nagham Qasim Kazim[2b],Firas Shawqi Algburi[2c] .

1 Anesthesia department/college of Al-Qalam University College/Iraq Author

2Chemistry department/college of science/ Tikrit university/Iraq Author

Email:yaser.an@alqalam.edu.iq[1a] ,Naghamkassim@tu.edu.iq[2b] ,, dr.firas.shawki@tu.edu.iq[2c]

Abstract

There is a significant correlation between kidney stones, type of food, environment, and the variety of medication taken, as well as genetic conditions, as well as the effect of the level of electrolytes on the formation of stones. This study was conducted in the laboratories of Kirkuk General Hospital and the Public Health Laboratory in Kirkuk Governorate from 1/12/2019 to 1/1/2021, Where the study included (60) samples of people with kidney stones ranging in age from (30-72) years, the number of men (32) men and the number of women (28) women, as well as (30) blood samples were collected from healthy people, where the number of men was (15) men and the number of women was (15) women, and they were chosen randomly from the residents of Kirkuk governorate.

This study also includes some biochemical variables: Levels of the hormone hepsidine and cortisol, And measuring the concentration of electrolyteschloride (Cl^-) and magnesium (Mg^{++}), [and body mass index). In addition, the age relationship was studied and the number of times stones formed as well as gender were studied and compared with the control group. Where the current study showed:

The results showed that there was no significant difference in the levels of the hormone abelin in all the variables studied, as for the hepcidinhormone, the results showed a high significant decrease ($p < 0.0001$) in the levels of the hepcidinhormone in the group of patients with kidney stones compared to the control group, as well as the results showed a significant difference. ($p < 0.0001$) in the two groups of patients compared with the control group at body mass, and the results showed that there was no significant difference in the levels of the Hepatidine hormone when the rest of the variables studied,Also, a significant increase ($p < 0.0001$) was found in their effect on the level of the hormone cortisol in the group of patients with kidney stones compared to the control group, and also a significant decrease ($p < 0.0001$) was found in the levels of the hormone cortisol among the group of patients with kidney stones for female patients compared with males Patients, while there is no significant increase in patients for the rest of the variables studied in this study.

1-Introduction

HepcidinA normal iron balance depends on the close relationship between metabolized iron absorption and the body's need for iron[(1)]. There is a major factor that plays a role in storing iron stores in the body and absorbing intestinal absorptive cells. This factor is a hepatic peptide

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 4, 2021, Pages. 9137 - 9147
Received 05 March 2021; Accepted 01 April 2021.

hormone called Hepcidin[2]. This hormone has been discovered as a mediator in natural immunity, as its level increases with inflammation and infection, and this hormone plays an important role in regulating the process of iron absorption from the intestine and its recycling, as well as in the process of storing iron[3]. Hepcidinis a peptide hormone made in the liver that was discovered in 2000[4]. And in humans, it is called HAMP (Hepcidin antimicrobial peptide), which is the gene encoding hepcidin. It was initially called the hepsidin peptide antimicrobial hormone expressed in the liver. It has an antimicrobial effect. The Hep-prefix in the designation of hepsidin refers to the production of this peptide in the liver which possesses a microbicide referred to by the-cidin portion of this designation[5]. Hepicidin was extracted in mice in both iron overload conditions as in inflammation[6].

Kidney stones are mineral concretions in the renal calyces and pelvis that are found free or attached to the renal papillae. By contrast, diffuse renal parenchymal calcification is called nephrocalcinosis[7]. Stones that develop in the urinary tract (known as nephrolithiasis or urolithiasis) form when the urine becomes excessively supersaturated with respect to a mineral[8], leading to crystal formation, growth, aggregation and retention within the kidneys[9]. Globally, approximately 80% of kidney stones are composed of calcium oxalate mixed with calcium phosphate (CaP). Stones composed of uric acid[10], struvite and cystine are also common and account for approximately 9%, 10% and 1% of stones, respectively[11]. Urine can also become supersaturated with certain relatively insoluble drugs or their metabolites, leading to crystallization in the renal collecting ducts (iatrogenic stones). For example, patients with HIV who are treated with protease inhibitors such as indinavir and atazanavir are at risk for developing nephrolithiasis[12]. Both indinavir and atazanavir are metabolized by the liver, with a considerable proportion of the drug excreted in the urine unchanged, leading to their crystallization and the formation of kidney stones[13]. Even when given as part of a multiple drug regimen, atazanavir can crystallize in the urine and form kidney stones[14].

Cortisol, also known as Hydrocortisone, is one of the steroid hormones that are synthesized from cholesterol in the adrenal cortex in the zonafasciculata region of mammals by the effect of the adrenocorticotropic hormone, which allows the cells to carry out most of the glucocorticoids and the carbohydrates that join the metabolites. With its functions in various tissues of the body, it is considered one of the stress and stress hormones [15]. When stress occurs, the brain response begins with the secretion of the hormone cortisol, which raises blood glucose [16], by inhibiting insulin secretion, and the liver begins to release glucose [17]. The highest level of cortisol reaches within half an hour after the onset of stress, and to remove it approximately two hours are required in case of severe stress, the cortisol level is twenty times higher than normal [18].

Chloride is found in the extracellular fluid (ECF) and is the main negative ion in this fluid. Chloride is one of the important factors in maintaining the proper distribution of water inside the body, and it helps to maintain the osmotic pressure in the cells of the body [19], and it works to maintain the natural balance between positive and negative ions (normal anion-cation balance) in the vicinity of the external cellular fluid. Thus, it preserves the vitality of cells[20]. The chloride ion is present in the clear gastric juice at a concentration slightly higher than the blood plasma as the presence of chloride participates in the formation of hydrochloric acid in the stomach. Deficiency in blood leads to decreased growth, loss of appetite, lethargy and weakness [21].

Magnesium is one of the important elements in the human body and its presence reflects good

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 4, 2021, Pages. 9137 - 9147
Received 05 March 2021; Accepted 01 April 2021.

health, and the body contains 1 (Kg) of magnesium, most of which is in the bones and soft tissues such as the liver, kidneys and muscles, and only (1)% of it is present in the ECF and 20 - 30% of it is Associated with proteins and the rest is in the form of a free ion, the body needs magnesium in many vital reactions and maintains normal muscles and is important in the functioning of the nervous system and maintains steady heart rhythmic beats and gives a healthy immune system and contributes to regulating blood sugar levels and maintains pressure Normal blood [(22)]. It also increases the efficiency of the renal tubules of citrate absorption, about (25-66)% of it is absorbed in the upper part of the intestine and this absorption process is inhibited by increasing the concentration of calcium and phosphate ions, while vitamin D3 and the hormone PTH play a key role in increasing its absorption, which in turn works. On inhibiting the secretion of thyroid hormones [(23)].

2-Materials and Methods

Samples

Patients group: This study was conducted in the laboratories of Kirkuk General Hospital and the Public Health Laboratory in Kirkuk Governorate from 12/1/2019 to 1/1/2021, where the study included (60) samples of people with kidney stones whose ages ranged from (30-72) years. The number of men is (32) men and the number of women is (28) women. Pathological cases with kidney stones were confirmed after conducting clinical examinations and referring them to the specialist doctor and conducting an ultrasound examination (sonar).

group control:(30) blood samples were collected from healthy people, where the number of men was (15) men and the number of women was (15) women, and they were randomly selected from the population of Kirkuk governorate.

Collection Of Blood Samples: The blood was drawn from the vein using a needle (syringe) in the size of (ml5) and the blood was placed in a vacuum tube containing GEL (Tube gel), which is free from the anticoagulant substance EDTA, and the blood was left in this tube at room temperature for (30 minutes) The serum was separated by a Centrifuge centrifuge at a speed (3000 rpm) for a period of (20 minutes). Then, it was transferred to its plain plastic tube and stored at -20 ºC. The exact questions of the patients and companions were recorded through a special questions form for each patient.

Diagnostic kits (Hepcidin) : the manufacture company Bioassay Technology laboratory.

Magnesium ion the manufacture company Biolabo

Cortisol TOSOH AIA-360()

Chloride ion ion in blood serum were directly quantified by the Easylyte Na + analyzer based on Ion Selective Electrodes (ISE) technology[(24)].

3-Results

Hepcidin Hormone: Table (1-1) and Figure (2-3) show the mean ± standard deviation (SD) of the concentration of hepsin hormone in the blood serum where there is a high significant decrease ($p < 0.0001$) in the levels of hepsin hormone in the group of people who ran in the combination of results. (± 14.50469 974.8500), (± 13.58144 1005.5900) in control passengers, respectively, as are from Table (2-3) (signs of aging and age comparison of patientsThe results for the age group (30-49): (± 33.206 978.394), (± 33.206 1000.394) for patients and the control group respectively, as well as for the age group (50-72) (970.845 ± 19.16), (± 19.163 1009.845) for patients and the control group. Respectively, there were no significant differences in the female patient group compared with the female control group (± 17.683 961.823), (17.683 ± 1010.823) for patients and

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 4, 2021, Pages. 9137 - 9147
Received 05 March 2021; Accepted 01 April 2021.

the control group, respectively, as well as the absence of significant differences in the male patient group compared to the male control group (± 30.040 985.858.), (± 30.040 999.858) for patients and the control group respectively, and there was a significant difference (p <0.0001) in the two patient groups.Compared with the control group whose body mass ranges between (25-29) (± 33.397 956.585), (± 33.397 1001.585) for patients and the control group respectively, as well as the group of patients whose body mass ranges (30-33) (± 34.264 989.030), (34.264 ± 1007.030) for the patients and the control group, respectively. Likewise, there was no significant difference for patients who had stones more than once compared with the group of patients who had stones for the first time (± 25.292 966.313), (± 54.225 982.568), for the group of patients who had stones for the first time and who had more than once in a row.

Table (1-1) levels of the hormone pg / ml hepsin in the blood serum of the control group and the patient group depending on age, gender, body mass and number of times stones

Groups		**Hepcidinpg/ml**	
		Mean ± SD	
		Control	**Patients**
Total		**±13.581441005.5900**	**± 14.50469 974.8500**
Age year	**(49-30)**	**± 33.206 1000.394**	**± 33.206 978.394**
	(72-50)	**± 19.163 1009.845**	**970.845 ± 19.16**
Gender	**Male**	**± 30.040999.858**	**± 30.040985.858**
	Female	**± 17.6831010.823**	**± 17.683961.823**
BMI	**(25-29)**	**± 33.397 1001.585**	**± 33.397 956.585**
	(30-33)	**± 34.264 1007.030**	**± 34.264989.030**
	How often	**Once**	**± 25.292 966.313**
		More than once	**± 54.225 982.568**
P value			
Total		**<0.01**	
Age year	**(49-30)**	**Patients**	**0.565**
	(72-50)		
	(49-30)	**Control**	**0.781**
	(72-50)		
Gender	**Male**	**Patients**	**0.295**
	Female		
	Male	**Control**	**0.921**
	Female		

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 4, 2021, Pages. 9137 - 9147
Received 05 March 2021; Accepted 01 April 2021.

BMI	**25-29**	**Patients**	**0.05**
	30-33		
	25-29	**Control**	**0.890**
	30-33		
How often	**Once**	**Patients**	**0.165**
	More than once		

Cortisol Hormone :Table (1-2) shows the mean ± standard deviation (SD) of the cortisol hormone concentration in the blood serum of both the control group and the patient group. Where a significant increase ($p < 0.0001$) was found in their effect on the level of the hormone cortisol in the group of patients with kidney stones compared with the control group, and also a significant decrease ($p < 0.0001$) was found in the levels of the hormone cortisol among the group of patients with kidney stones for female patients compared with male patients. While there is no significant increase in patients for the rest of the variables studied in this study.

Table (1-2) Levels of the hormone cortisol µg / dl in the serum of the control group and the patient group depending on age, gender, body mass and number of times stones

Groups			**Cortisol µg/dl**	
			Mean ± SD	
			Control	**Patients**
Total			**15.1000 ± 1.48649**	**± 1.60516 20.8150**
	Age year	**(49-30)**		**± 1.562 20.700**
		(72-50)		**± 1.744 21.032**
	Gender	**Male**		**± 1.586 21.323**
		Female		**± 1.335 20.135**
	BMI	**(25-29)**		**± 1.67420.818**
		(30-33)		**± 1.637 20.815**
	How often	**Once**		**± 1.488 16.142**
		More than once		**± 1.56425.309**
	P value			
	Total		**0.0001**	
Age year	**(49-30)**	**Patients**	**0.456**	
	(72-50)			
	(49-30)	**Control**		

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 4, 2021, Pages. 9137 - 9147
Received 05 March 2021; Accepted 01 April 2021.

	(72-50)		
Gender	**Male**	**Patients**	**0.002**
	Female		
BMI	**25-29**	**Patients**	**0.994**
	30-33		
How often	**Once**	**Patients**	**0.006**
	More than once		

Chloride ion:Table (1-3) shows the mean ± standard deviation (SD) of the chloride ion in serum of both the control group and the patient group. The presence of a significant increase ($p < 0.0001$) in the blood serum of patients with kidney stones compared to the control group, as well as the presence of a significant increase ($p < 0.0001$) in the blood serum of patients with kidney stones in the age group (50-72) compared with the age group (30-49).), As well as the presence of a high significant increase ($p < 0.0001$) in the blood serum of kidney stone patients for patients who had stones more than once compared to patients who first formed them. There was no significant difference for the rest of the variables studied in this study.

Table (3-10): mEq / L chloride ion levels in the blood serum of the control group and the patient group depending on age, gender, body mass and number of times stones

Groups		**Chloride ion mEq/L**	
		Mean ± SD	
		Control	**Patients**
Total		**± 6.25315 110.7767**	**± 6.07431 126.0650**
Age year		**(49-30)**	**± 6.070 110.344**
		(72-50)	**±4.861144.327**
Gender		**Male**	**± 5.876 125.910**
		Female	**± 6.652 126.327**
BMI		**(25-29)**	**± 6.024 125.033**
		(30-33)	**± 6.031127.256**
How often		**Once**	**± 4.935120.550**
		More than once	**± 4.493129.541**
	P value		
	Total	**0.00001**	
Age	**(49-30)**	**Patients**	**0.001**

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 4, 2021, Pages. 9137 - 9147
Received 05 March 2021; Accepted 01 April 2021.

year	**(72-50)**		
Gender	**Male**	**Patients**	**0.804**
	Female		
BMI	**25-29**	**Patients**	**0.161**
	30-33		
How often	**Once**	**Patients**	**0.021**
	More than once		

Magnesium ion :Table (3-4) shows the mean ± standard deviation (SD) of the magnesium ion in blood serum of both the control group and the patient group. The presence of a significant decrease ($p < 0.0001$) in the blood serum of patients with kidney stones compared to the control group, as well as the presence of a significant decrease ($p < 0.0001$) in the blood serum of patients with kidney stones in the age group (50-72) compared with the age group (30-49).), As well as the presence of a high significant decrease ($p < 0.0001$) in the blood serum of kidney stone patients for patients who had stones more than once compared to patients who first formed them. There was no significant difference for the rest of the variables studied in this study.

Table (1-4) levels of mEq / L magnesium ion in the serum of the control group and the patient group depending on age, sex, body mass and number of times stones

Groups	**Magnesium ion** mEq/L	
	Mean ± SD	
	Control	**Patients**
Total	**± 0.17436 2.3167**	**± 0.281021.5967**
Age year	**(49-30)**	**± 0.273 1.581**
	(72-50)	**± 0.227 1.497**
Gender	**Male**	**± 0.277 1.597**
	Female	**± 0.300 1.604**
BMI	**(25-29)**	**± 0.300 1.664**
	(30-33)	**± 0.2461.530**
How often	**Once**	**± 0.151 1.875**
	More than once	**± 0.2081.297**

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 4, 2021, Pages. 9137 - 9147
Received 05 March 2021; Accepted 01 April 2021.

		P value	
	Total	0.00001	
Age year	(49-30)	Patients	0.021
	(72-50)		
Gender	Male	Patients	0.927
	Female		
BMI	25-29	Patients	0.067
	30-33		
Howoften	Once	Patients	< 0.0001
	More than once		

4- Discussion

Hepcidin Hormone: The results of the current study agree with researchers Norishi Ueda and Kazuya Takasawa 2018 who found a decrease in the levels of the hormone hepsidin in kidney patients [(25)]. The reason may be attributed to the low levels of the hormone hepsidin as a result of the increase in iron levels, as the high iron in kidney stone patients contributes to the low level of hepsidin. As a result of the accumulation of this iron in the body and its increased absorption by the intestine, this disorder causes an increase in the androgen that is also responsible for the disturbance in the levels of the hormone hepcidin[(26)], as the increase in iron levels leads to a decrease in the level of the hormone hepcidinas a result of the accumulation of iron in the body and its increased absorption by the intestine [(5)] ,It is also believed that the hormone hepcidinis linked with Ferritin, which increases iron absorption and thus reduces the concentration of hepsin in the blood [(25)]. The results of the current study showed a significant decrease of the hepcidinhormone in patients with kidney stones compared to the control group in BMI, and this is consistent with Nicole U. Stoffel and his et al 2020 who found a decrease in the level of the hormone hepcidinwhen increasing body mass[(26)], where they found that the reason is due to the distribution of fats in the body and its effect on iron metabolism, which affects the absorption of iron in the body and the level of iron in the blood rises [(27)]. As for the rest of the variables that were studied on the hepsin hormone in this study, they were not significant.

Cortisol Hormone:The results of the current study are consistent with what researchers SuraZahim Hussein and Susan Jameel ALI 2019 reported[(28)]. They found an increase in the levels of the hormone cortisol in kidney patients [(29)] , The results of the current study also showed a lower level of cortisol in sick females compared to sick males and this is consistent with what was reported by the researcher Clare Netherton and his et al 2004 [(30)], and the reason may be attributed to the effect of the male hormone testosterone on the hypothalamic pituitary hormone (HPA), which In turn, it increases the hormone cortisol [(29)].

Chloride ion: The results of the current study agree with what was reported by Vincenzo Panuccio 2020 and his et al[(31)]. Perhaps the main reason for the high levels of chloride ion is the loss of the

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 4, 2021, Pages. 9137 - 9147
Received 05 March 2021; Accepted 01 April 2021.

kidney's effectiveness in maintaining the acid-base balance [19]. Moreover, the results showed a high significant difference in the age groups (49-72) years compared with the age group (30-49) years, and these results are consistent with what was reported by Richard J. Miron 2018 and his et al[32] and it is believed that the reason is Low blood sodium, as well as the use of diuretics that increase the level of chloride, as well as some diseases such as diabetes (21), The results also showed an increase in the level of chloride in patients who had stones more than once compared to patients who had formed for the first time, and these results are consistent with what was reported by the researcher AkshayRandad MS 2019 and his et al[33]. The reason may be the poor performance of the kidneys and some other diseases that affect the kidneys, such as diabetes and blood pressure [20].

Magnesium ion:The results of the current study agree with what was reported by the researcher LvoLaranjinha 2019 and his group [34], and this may be due to some factors, including malnutrition or infection with some chronic diseases that led to a decrease in the level of magnesium in patients and thus led to an increase in the permeability of this element with urine, which led to Excessive urinary magnesium as well as the low level of magnesium is one of the most important factors that lead to the occurrence of kidney stones because the high magnesium prevents the occurrence of kidney stones and when it is low, these stones formed and this has been confirmed by studies by Preminger (1994)[35] ,As for the effect of age on the level of magnesium, this was consistent with what Wolf, 2004[36] found who indicated the superiority of age groups of healthy people compared to patients, and the reason may be due to nutritional and genetic factors as some patients have a gene that controls the level of calcium when exposed to a different condition. Normally, it reduces its level in the blood through the effect of this gene on the utilization of the magnesium present in the food, so the level of magnesium decreases, which resulted in an imbalance in the metabolism of calcium and its deposition in the form of kidney stones [23]. Once compared with patients who first conceived and this is consistent with what was stated by the researcher Omer 2003[37], the reason may be due to the impairment of the kidneys and their poor functioning and cannot prevent the excretion of chloride with the diuresis[22].

References

1. Galesloot, T. E. et al. Serum hepcidin: reference ranges and biochemical correlates in the general population. Blood 117, e218–e225 (2011).
2. Sim M, Garvican-Lewis LA, Cox GR, et al. Iron considerations for the athlete: a narrative review. Eur J Appl Physiol. 2019;119:1463-1478.
3. Diepeveen LE, Laarakkers CMM, Martos G, et al. Provisional standardization of hepcidin assays: creating a traceability chain with a primary reference material, candidate reference method and a commutable secondary reference material. ClinChem Lab Med.2019;57:864-872.
4. Laarakkers CMM, Wiegerinck ET, Klaver S, et al. Improved mass spectrometry assay for plasma hepcidin: detection and characterization of a novel hepcidin isoform (HS Randeva, Ed.). PLoS One. 2013;8:e75518.
5. Sim M, Dawson B, Landers G, et al. Interleukin-6 and hepcidin levels during hormone-deplete and hormone-replete phases of an oral contraceptive cycle: a pilot study. Ann Nutr Metab.2017;70:100-105.
6. Sarafidis, P.A.; Rumjon, A.; MacLaughlin, H.L.; Macdougall, I.C. Obesity and iron

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 4, 2021, Pages. 9137 - 9147
Received 05 March 2021; Accepted 01 April 2021.

deficiency in chronic kidney disease: The putative role of hepcidin. Nephrol. Dial. Transplant. 2012, 27, 50–57.

7. F. Ferdinal, D. Limanan, R. D. Rini, R. Alexsandro, and R. Helmi, "Elevated levels of apelin-36 in heart failure due to chronic systemic hypoxia," International Journal of Angiology, vol. 28, no. 3, pp. 194–199, 2019.
8. L. M. Yamaleyeva, K. B. Brosnihan, E. Elsangeedy et al., "Systemic outcomes of (pyr(1))-apelin-13 infusion at mid-late pregnancy in a rat model with preeclamptic features," Scientific Reports, vol. 9, no. 1, article 8579, 2019.
9. A. Mughal and S. T. O'Rourke, "Vascular effects of apelin: mechanisms and therapeutic potential," Pharmacology & Therapeutics, vol. 190, pp. 139–147, 2018.
10. J. Pi, Y. Cheng, H. Sun et al., "Apln-CreERT:mT/mG reporter mice as a tool for sprouting angiogenesis study," BMC Ophthalmology, vol. 17, no. 1, p. 163, 2017.
11. F. Kazemi and S. Zahediasl, "Effects of exercise training on adipose tissue apelin expression in streptozotocin-nicotinamide induced diabetic rats," Gene, vol. 662, pp. 97–102, 2018.
12. F. Kazemi and S. Zahediasl, "Effects of exercise training on adipose tissue apelin expression in streptozotocin-nicotinamide induced diabetic rats," Gene, vol. 662, pp. 97–102, 2018.
13. S. Lv, X. Zhang, Y. Feng et al., "Intravenous administration of pyroglutamyl apelin-13 alleviates murine inflammatory pain via the kappa opioid receptor," Frontiers in Neuroscience, vol. 14, p. 929, 2020.
14. M. B. Wysocka, K. Pietraszek-Gremplewicz, and D. Nowak, "The role of apelin in cardiovascular diseases, obesity and cancer," Frontiers in Physiology, vol. 9, p. 557, 2018.
15. Sekar, M., Pandiaraj, M., Bhansali, S., Ponpandian, N. &Viswanathan, C. Carbon fiber based electrochemical sensor for sweat cortisol measurement. Sci. Rep. 9, 403 (2019).
16. Jang, H.-J. et al. Electronic cortisol detection using an antibody-embedded polymer coupled to a field-effect transistor. ACS Appl. Mater. Interfaces 10, 16233–16237 (2018).
17. device for noninvasive cortisol sensing. Sci. Adv. 4, eaar2904 (2018). 37. Jeong, G., Oh, J. & Jang, J. Fabrication of N-doped multidimensional carbon nanofibers for high-performance cortisol biosensors. Biosens. Bioelectron. 131, 30–36 (2019).
18. Dalirirad, S. &Steckl, A. J. Aptamer-based lateral flow assay for point of care cortisol detection in sweat. Sens. Actuators B Chem. 283, 79–86 (2019).
19. Panuccio V, Pizzini P, Parlongo G et al. Urine chloride self-measurement to monitor sodium chloride intake in patients with chronic kidney disease. ClinChemLabMed 2019; 57: 1162–1168.
20. Takada T, Imamoto M, Sasaki S et al. Effects of self-monitoring of daily salt intake estimated by a simple electrical device for salt reduction: a cluster randomized trial article. Hypertens Res 2018; 41: 524–530.
21. Raina AF, Bhat MA, Wani I, Kawaja M, Saleem M, Mudasir S, et al. 24-hour urinary constituents in stone formers : a study from Kashmir. Int J Adv Med. 2017;4(5):1477–82.
22. Miron RJ, Zucchelli G, Pikos MA, Salama M, Lee S, GuillemetteV,Fujioka-Kobayashi M, Bishara M, Zhang Y, Wang HL, ChandadF,Nacopoulos C, Simonpieri A, Aalam AA, Felice P, SammartinoG,Ghanaati S, HernandezMA, Choukroun J (2017) Use of platelet-rich fibrin in regenerative dentistry: a systematic review. Clin Oral Investig 21:1913–1927.

https://doi.org/10.1007/s00784-017-2133-z.

23. Harslof T, Rollghed L &Renjmark L. Huge variation in definition and reported incidence of postsurgical hypoparathyroidism: a systematic review. Endocrine 2019 64 176–183.
24. Wide, L. Hormon assays and their clinical applications –Ed Loraine J.A, et Bell E.T, 4eme edition , Churchill Livingstone, Edinburgh, London and New York , Human Pituitary Gonadotropins ,1976: 87-140 .
25. Norishi Ueda 1, and Kazuya Takasawa. Impact of Inflammation on Ferritin, Hepcidin and the Management of Iron Deficiency Anemia in Chronic Kidney Disease. Nutrients ; 2018. 10, 1173.
26. Kris V. Kowdley ,Eric M. Gochanour ,VinaySundaram, et al. Hepcidin Signaling in Health and Disease: Ironing Out the Details. Hepatology communications; 2021. VOL. 0, NO. 0.
27. Nicole U. stoffel, Carla El-Mallah, Michael B. Zimmermann. The effect of central obesity on inflammation, hepcidin, and iron metabolism in young women. International Journal of obesity; 2020.44 1291-1300.
28. SuraZahim Hussein and Susan Jameel Ali. Serum Thyroid Hormones and Cortisol in Patients with Chronic Renal Failure. The Medical Journal Of Tikrit University; 2019. 25 (1): 1-6.
29. Daniel D Bikle. The Free Hormone Hypothesis: When, Why, and How to Measure the Free Hormone Levels to Assess Vitamin D,Thyroid, Sex Hormone, and Cortisol Status. JBMR® Plus; 2021. Vol. 5, No. 1,(1-10).
30. Clare Netherton , Ian Goodyer , Alison Tamplin ,Joe Herbert. Salivary cortisol and dehydroepiandrosterone in relation to puberty and gender. Psychoneuro endocrinology ; 2004. 29 ,125–140.
31. Vincenzo Panuccio1, Francesca Mallamaci1, PatriziaPizzini, et al. Reducing salt intake by urine chloride self-measurement in non-compliant patients with chronic kidney disease followed in nephrology clinics: a randomized trial. Nephrol Dial Transplant; 2020. 1–8.
32. Richard J. Miron , AnikaDham,UttmaDham, et al. The effect of age, gender, and time between blood draw and start of centrifugation on the size outcomes of platelet-rich fibrin (PRF) membranes. Clinical Oral Investigations, 2018. https://doi.org/10.1007/s00784-018-2673-x.
33. AkshayRandad, MS,JustinAhn, MD,Michael R. Bailey, PhD, et al. The Impact of Dust and Confinement on Fragmentation of Kidney Stones by Shockwave Lithotripsy in Tissue Phantoms . JOURNAL OF ENDOUROLOGY , 2019 . Volume 33, Number 5, May Pp. 400–406.
34. Ivo Laranjinha, Patricia Matias, Jorge Dickson. Magnesium supplementation to prevent recurrence of renal stones. Port J NephrolHypert. 2019; 33(4): 231-236.
35. Preminger, G. M. Is there aneed for medical evaluation and treatment of nephrolithiasis in the ago of lithotripsy semin. J. Urol. 1994. Vol.12. No. 1: 51-64.
36. Wolf, J. S. (2004). Nephrolithiasis. UrolClin North AM. Vol. 25. No. 1: 40-67.
37. Omer, Z. K. (2003). Inhibitors of crystalluria in Calcium Oxalate stone formes. In vitro and In vivo study .M.S.c. Thesis college of medicine, University of Mosul.