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Serum taurine level versus endocan as potential biomarkers for early diagnosis of ischemic diabetic foot in type 2 diabetic patients

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Abstract

Objective: Our goal is to break the vicious cycle between diabetes and its critical complications by measuring two potential biomarkers (Endocan and Taurine) that are used as pre-diagnostic markers of diabetic complications (ischemic diabetic foot) in type 2 diabetic patients.

Methods: 90 diabetic patients were recruited from the National Institute of Diabetes and Endocrinology (NIDE); 70 patients had ischemic diabetic foot, and 20 diabetic controlled patients who did not have ischemic diabetic foot were designated diabetic controlled patients. Ten healthy, non-diabetic individuals signed up as volunteers. All patients and volunteers underwent a full clinical examination, investigation, and biochemical analysis (liver and kidney functions, lipid profile, CRP, albumin, and complete blood count), as well as measurements of FBG, 2PP, fructose amine, and the recently discovered two possible biomarkers endocan and taurine.

Results: The data demonstrated no significant difference in liver functions, renal functions, lipid profile, albumin and CBC except (WBCs) in all patients compared to the control group ($p > 0.05$). However, there is a substantial shift in WBCs, CRP, FBG, 2PP, and fructose amine ($p<0.05$). On the other hand, the data revealed a very substantial decrease in serum taurine and an increase in serum endocan in all diabetes patients based on the severity of the ischemic diabetic foot as compared to healthy controls.

Conclusion: Serum endocan levels are raised in diabetic patients based on the degree of inflammation. In contrast, the level of taurine decreases in proportion to the severity of the inflammatory foot. Thus, endocan and taurine are regarded as early diagnostic markers of ischemic diabetic foot complications.

Keywords: Ischemic Diabetic Foot; Endocane; Taurine; diabetes; diabetic complications

1. Introduction

Diabetes, also known as diabetes mellitus, ["Diabetes Mellitus (DM) – Hormonal and Metabolic Disorders" 2022] is a group of common endocrine diseases characterized by sustained high blood sugar levels [Diabetes "WHO," 2023].

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Diabetes is due to either the pancreas not producing enough of the hormone insulin or the cells of the body becoming unresponsive to insulin's effects. [Shoback DG, Gardner D, eds. 2011] Classic symptoms include polydipsia (excessive thirst), polyuria (excessive urination), polyphagia (excessive hunger), weight loss, and blurred vision. If left untreated, the disease can lead to various health complications, including disorders of the cardiovascular system, eyes, kidneys, and nerves. [Kitabchi AE, Umpierrez GE, Miles JM, Fisher JN, July 2009]. Diabetes accounts for approximately 4.2 million deaths every year ["IDF DIABETES ATLAS Ninth Edition 2019"),]. with an estimated 1.5 million caused by either untreated or poorly treated diabetes. ["Diabetes." World Health Organization, 2023].

The major types of diabetes are type 1 and type 2. [US National Institutes of Health. 2024].The most common treatment for type 1 is insulin replacement therapy (insulin injections), while anti-diabetic medications (such as metformin and semaglutide) and lifestyle modifications can be used to manage type 2. Type 1 diabetes is an autoimmune condition where the body's immune system attacks the beta cells in the pancreas, preventing the production of insulin. This condition is typically present from birth or develops early in life. Type 2 diabetes occurs when the body becomes resistant to insulin, meaning the cells do not respond effectively to it, and thus, glucose remains in the bloodstream instead of being absorbed by the cells. [UVA,2025]

The number of people diagnosed as living with diabetes has increased sharply in recent decades, from 200 million in 1990 to 830 million by 2022. [Diabetes, 2024] It affects one in seven of the adult population, with type 2 diabetes accounting for more than 95% of cases. These numbers have already risen beyond earlier projections of 783 million adults by 2045. [international diabetes federation, 2023] The prevalence of the disease continues to increase, most dramatically in low- and middle-income nations. [De Silva AP , et al. April 2018] Rates are similar in women and men, with diabetes being the seventh leading cause of death globally. [Vos T, et al. December 2012, the top 10 causes of death ,2021,2024]. The global expenditure on diabetes-related healthcare is an estimated US$760 billion a year. [Bommer C , et al. May 2018]. Epidemiological studies have shown that approximately 15% of people with diabetes will develop diabetic foot. The incidence of diabetic foot reaches approximately 2% per year, and the recurrence rate of ulcers in the first year after healing is 30–40%. Of the patients, 85% eventually have to undergo amputation, and the 5-year survival rate of patients following amputation is only 50%. [Xie et al., 2022]

There are three different forms of diabetic foot ulcers:

- **Neuropathic ulcers** occur where there is peripheral diabetic neuropathy, but no ischemia caused by peripheral artery disease.
- **Ischemic ulcers** occur where there is peripheral artery disease present without the involvement of diabetic peripheral neuropathy.
- **Neuro ischemic ulcers** occur where the person has both peripheral neuropathy and ischemia resulting from peripheral artery disease.

Endocan is a novel inflammatory marker[Angiology ,2020], also known as human endothelial cell-specific molecule (HESM), [Scuruchi M, 2021] is a dermatan sulfate proteoglycan With a molecular weight of (50 kDa) [Bechard et al., 2000]. it was later renamed to endocan in 2001, because of its involvement in inflammation and endothelial dysfunction. Endocan is thought to be a potential immune-inflammatory marker for cardiovascular disease. It is primarily produced by endothelial cells and is a soluble proteoglycan. It is produced mostly in the lungs, vascular endothelial cells, cardiomyocytes, pulmonary capillaries, skin, kidneys, digestive system, liver, brain, and lymph nodes [Zhang SM,2012]. Endocan's ability to interact with bioactive proteins regulates various biological processes, including proliferation, neovascularization, and cellular adhesion. Endocan is known as a marker of angiogenesis and endothelial cell activity. Endocan can also promote microvascular permeability and leukocyte adhesion by producing pro-inflammatory cytokines. The endocan's predictive usefulness has been proven in inflammatory illnesses and tumor progression., sepsis, hypertension, diabetes, heart disease, chronic kidney disease and transplant rejection. Similarly, a positive correlation was found between endocan and cardiovascular risk factors, such as hypertension, diabetes mellitus and chronic renal failure. ESM-1[Lassalle p,1996] has also been estimated as a biomarker of endothelial dysfunction. Plasma level is elevated in lung injury, Chronic Kidney Disease (CKD), sepsis and Diabetic Proliferative Retinopathy (DPR) [Scherpereel et al., 2006]. Its secretion is controlled by other cytokines such as tumor necrosis factor (TNF-α), (interleukin-1β) IL-1β lipopolysaccharide and angiogenic factors such as vascular endothelial growth factor (VEGF), and down-regulated by interferon-γ and IL-6 [Voiosu T, Balanescu P, Bengus A, Voiosu A, Baicus CR, Barbu M, et al. 2014]. Intracellular adhesion molecule (ICAM)-1 and vascular cell adhesion molecule (VCAM)-1 expression can be affected by inflammatory substances including IL-1β and TNF-α, which can also up-regulate endocan expression. We find The endothelium exerts important functions on inflammation, angiogenesis, coagulation and tumour invasion, mainly via the regulation of receptor/ligand interactions and release of several mediators [Balta S, Mikhailidis DP, Demirkol S, et al. 2015] . Cell adhesion molecules (CAMs) are cell-surface proteins associated with cell binding;

attaching leukocytes to endothelial cells via CAMs requires inflammation mediated signaling pathways. CAMs have an effect on cell adhesion, leukocyte collection, immunological events and inflammatory reactions, resulting in rounding and transmigration of leukocytes. Lymphocyte function-associated antigen-1 (LFA-1), one of the ligands on the surface of leukocytes, enables their binding to CAMs on the endothelium [Tayman MA, O¨ nder C, Kurgan, et al. 2020] . LFA-1, one of the adhesion molecules present on lymphocytes and other leukocytes, belongs to the integrin superfamily, and acts as a key factor in the migration of leukocytes into tissues. The binding of LFA-1 to CAMs is an important step for the adhesion and transmigration of leukocytes to the endothelium, and it also stimulates signaling pathways important for T-cell differentiation, the increased production of ROS and the impairment of NO availability can induce and maintain the inflammatory state of the blood vessel wall. This process promotes the recruitment of white blood cells and the influx of blood lipids and lipoproteins into the sub- endothelial space, leading to atherosclerotic plaque formation. [Libby P,et al.2009]. These properties illustrate its potential role as a biomarker of endothelial dysfunction and inflammation. Endocan has been identified as a pro inflammatory mediator that binds to LFA-1 on human leukocytes and regulates LFA-1 interactions with CAMs. It was also shown that endothelial damage, activation and dysfunction caused by oxidative stress increase endocan levels, endocan may significantly predict progression and response to treatment [Lin et al., 2023].

The amino sulfuric acid (Taurine) (Tau), also known as 2-aminoethanesulfuric acid, Taurine ($C_2H_7NO_3S$) is commonly present in animal tissues and is not protein genic. It makes up as much as 0.1% of the total weight of an adult human being and is a key component of bile. It is regarded as an immunological marker and contributes significantly to glucose homeostasis. Taurine exerts effects in glucose homeostasis through two known mechanisms: i) By its effects upon β-cell insulin secretion. ii) By interfering with the insulin signaling pathway and post-receptor events [Zheng et al., 2016]. Its lack can result in metabolic dysfunction and is linked to the emergence of almost all diabetes problems [Sirdah, 2015].

Many evidences support that taurine is a cytoprotective agent in a variety of tissues. Taurine modulates a variety of cellular functions, including antioxidation, modulation of ion movement, osmoregulation, modulation of neurotransmitters and conjugation of bile acids [Chorazy et al., 2002], modulate synthesis of pro inflammatory cytokines and play an important role in initiation and progression of immune response [Chorazy et al., 2002], More ever it is protective against hyperglycemia [Franconi et al., 2004], hypertension [Moloney et al., 2010], and endothelial dysfunction [Tabassum et al., 2006].

In this study we focused on one of the diabetic complication of T2DM that is ischemic diabetic foot. Ischemic means reduced blood flow to an area of the body. Our aim to measure immune marker (TAURINE) & novel inflammatory marker (ENDOCAN) levels in type 2 diabetic patients with ischemic diabetic foot. The possibility of using taurine and endocan as an early diagnostic marker for inflammation and macro vascular diabetic complication will be studied.

2. Patients and methods

2.1. Patients

After their consent ,90 diabetic outpatients' clinics (male and female) with T2DMfrom National institute of diabetes & Endocrinology, were selected for the study. Besides a healthy control group of 10 volunteers were enrolled, their ages (25-70 years old) will be chosen from diabetes institute. Study protocol will be approved by the general organization for teaching hospitals and institutes. All subjects will be given a written informed consent after the nature of the procedure will be explained. The patients will be divided into the following groups according to Complete their clinical examination, investigation and biochemical analysis:

2.1.1. Two groups will be formed from the patients, in addition to the frank control group

- Group (1) frank control group (n= 10)
- Group (2) Controlled diabetic group (n=20). The patients don't suffer from macro-vascular diabetic complication (ischemic diabetic foot) or any other complications. They depend on anti- hyperglycemic medication (tablet or insulin). Their fructose amine level ranges from 200 to 285 umol/L.
- Group (3) Diabetic with ischemic diabetic foot group (n=70). Patients suffer from ischemic diabetic foot. After diagnosed by different types of diagnosis such as Doppler flow parameters in femoral arteries, palpating foot pulses and measuring blood pressure in the foot and toes. The visual appearance of ischemia might be indicated by the presence of poor reperfusion to the foot, or black gangrenous toes (tissues death to part of the foot), Foot ulcer will be defined as a full-thickness skin defect that required ≥14 days for healing [**Jeffcott et al., 2005**].

Patients with inflammatory or infectious diseases, autoimmune and rheumatic diseases, cancer, hematological diseases, and those who were under treatment with anti-inflammatory drugs, pregnant and lactating female patients were excluded. We also excluded patients with recent venous thromboembolism.

2.2. Testing & gathering of sample

About 10 cm, will be collected from patients. A portion of the blood will be collected on EDTA for the determination of CBC. The remaining part was centrifuged for 20 min. at 3000 rpm after being allowed to clot for 2 hours at 4 ^{o}c without shaking to obtain the serum to make the Clinical examination. we will split the serum into two portions:

The first section will include the liver function enzymes (ALT and AST), kidney function parameter (Creatinine and eGFR), albumin test, lipid profile, blood sugar (2 -hour postprandial &fasting sugar), fructose amine, and Immunological analysis of C-reactive protein (CRP).

- The second portion was kept at -20 ^{o} c in a deep freezer until the Taurine and Enducan test assay.
- We use enzyme linked immune assay (ELISA) kit to assess Taurine and Enducan.
- Instrument name: Name: plate reader, made in Italy by das company, model: A3, V: 230v, A: 0.3, Hz: 50 – 60.

2.3. Statistical analysis

Results were expressed as mean ± SD. Data will be evaluated with ANOVA test and compared with post hoc test (Tukey test). The differences and similarities among the different experimental groups will be examined. Values were considered significant at $p < 0.05$.

3. Results

Complete clinical examination, investigation and biochemical analysis (liver and kidney functions, lipid profile, CRP, albumin, and complete blood count), as well as measurements of FBG, 2PP, fructose amine, and the recently discovered two possible biomarkers endocan and taurine, were measured for all diabetic patients and volunteers.

Table 1 Taurine Vs Endocane and added to Fasting blood glucose (FBG), after 2hours postprandial (2PP) and fructose amine (FRUCT) in different groups of patients

condition Parameter	Endocane (Pg/ml)	Taurine (µ.mol/l)	FBG (mg/dl)	2pp (mg/dl)	FRUCT. (Umol/l)
Frank Group N=10	50.05± 5.08	58.20±8.67	68.6± 10.6	84.3± 18.19	184.2± 20.59
Control diabetic patients Group N=20	257.03±44.87	40.2± 2.9	88.5±15.02	173.3±8.1	292.2±17.5
Ischemic diabetic foot patients Group N=70	451±93.2	17.99±16.31	177.56±75.33	250.48±81.24	323.91±34.84

*The mean difference is significant at the 0.05 level. * Data are expressed as mean ± SD
* p value >0.05 non-significant, * significant at value <0.05, *highly significant at level <0.01
* very highly significant <0.001.

The most interesting point in our results was illustrated in table (1). When the serum level of endocan observed in the diabetic control was highly significantly ($p<0.01$) (257.03 ± 44.87) compared to its level recorded in frank group (50.05 ± 5.08). these levels were elevated parallel to the severity of ischemic diabetic foot which are very highly significant ($p<0.001$) (451±93.2). in contrast to the serum level of taurine observed in the diabetic control was highly significantly ($p<0.01$) (40.2± 2.9) compared to its level recorded in frank group (58.20±8.67). these levels were decreased parallel to the severity of ischemic diabetic foot which are very highly significant ($p<0.001$) (17.99±16.31).

The value of FGB in control diabetic group recorded significant change ($p<0.05$) (88.5± 15.02) compared to frank group, but showed very high significance ($p<0.001$) compared to frank group in ischemic diabetic foot group (177.56 ±75.33).

The value of 2pp and fructose amine recorded very high significance in both control diabetic group and ischemic diabetic foot group ($p<0.001$) compared to frank group.

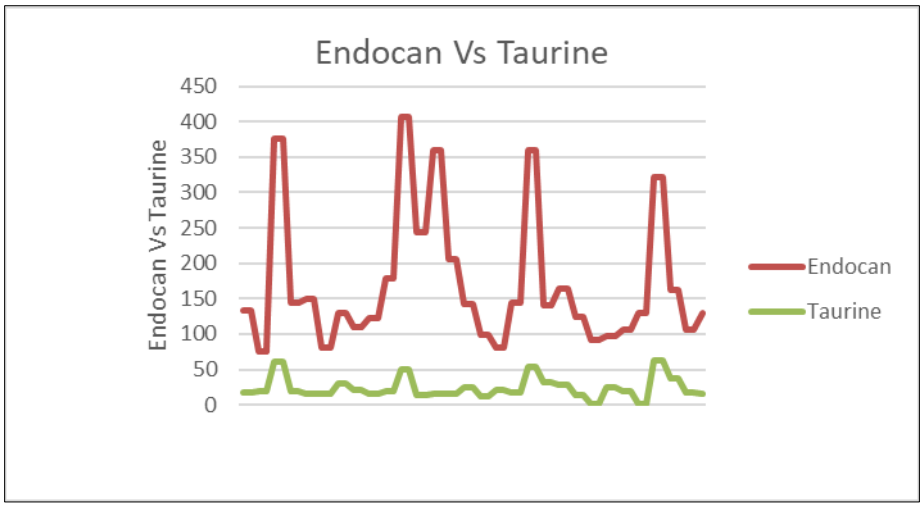

Figure 1 Endocan Vs taurine level

ABS. Absorbance (450 nm) Concentration of Taurine (µ. mol/l) Concentration of Endocane (Pg/ml)

There is found inverse relation between endocan and taurine level in type 2 diabetic patients with ischemic diabetic foot.

Table 2 Complete Blood picture in different groups of patients

Condition Parameter	**HB (g/dl)**	**RBCs (x10 6/µl)**	**WBCs (x 10 3/µl)**	**PLT (x 10 3/µl)**
Frank Group N=10	11.59± 1.03	3.78± 0.33	6.15± 1.26	154± 18.9
Control diabetic patients Group N=20	11.07±0.89	3.8±0.29	7.51±1.3	204.8±52.8
Ischemic diabetic foot patients Group N=70	12.07±1.15	4.2±0.91	33.39±0.646	207.18±45.32

*The mean difference is significant at the 0.05 level. * Data are expressed as mean ± SD

In relation to the frank group the hematological changes in most groups of patients showed a non-significant changes ($p>0.05$) but WBCs in ischemic diabetic foot group showed very highly significance ($p<0.001$) (33.39±0.646) related to frank group as demonstrated in table 2.

Table 3 Liver enzymes, Kidney functions, ALb, and CRP in different groups of patients

Condition Parameter	**ALT (U/l)**	**AST (U/l)**	**Creat (mg/dl)**	**eGFR (m/min)**	**ALb (g/dl)**	**CRP (mg/dl)**
Frank Group N=10	16.21± 4.98	16.9± 4.21	0.63± 0.18	85.7± 12.3	3.65± 0.422	0.59± 1.81
Contorl diabetic patients Group N=20	18.84±10.9	17.81±4.68	0.76±0.22	88.1±22.5	3.94±0.47	3.13±1.43
Ischemic diabetic foot patients Group N=70	20.06±8.35	20.72±6.32	0.90±0.32	90.05±24.27	4.06±0.465	5.75±1.75

*The mean difference is significant at the 0.05 level. * Data are expressed as mean ± SD

Liver and kidney functions in all groups demonstrated non significance change ($p>0.05$), also albumin level in all groups demonstrated non significance change ($p>0.05$), but CRB showed high significance ($p<0.01$) (3.13±1.43) in diabetic control group and very highly significance ($p<0.001$) (5.75±1.75) in ischemic diabetic foot group compered to frank group.

Table 4 Lipid Profile in different groups of patients

Condition Parameter	**CHOL (mg/dl)**	**TRI (mg/dl)**	**HDL (mg/dl)**	**LDL (mg/dl)**
Frank Group N=10	124.15± 28.16	87.18± 15.62	63.08± 19.64	58.43± 10.54
Contorl diabetic patients Group N=20	155.5±25.6	91.9±21.35	72.29±11.16	61.35±5.37
Ischemic diabetic foot patients Group N=70	184.15±18.95	110.53±18.85	77.930±11.2	72.9±7.9

*The mean difference is significant at the 0.05 level. * Data are expressed as mean ± SD

Lipid profile showed non-significant changes ($p>0.05$) in all groups of patients compared to frank group.

4. Discussion

In the current study, we found that the number of people living with diabetes rose from 200 million in 1990 to 830 million in 2022. Prevalence has been rising more rapidly in low- and middle-income countries than in high-income countries. More than half of people living with diabetes did not take medication for their diabetes in 2022. Diabetes treatment coverage was lowest in low- and middle-income countries.

Diabetes causes blindness, kidney failure, heart attacks, stroke and lower limb amputation.

In 2021, diabetes and kidney disease due to diabetes caused over 2 million deaths. In addition, around 11% of cardiovascular deaths were caused by high blood glucose. [Global Burden of Disease Study. 2021,2024] in Egypt 6.1% to 29.3 % of diabetes patient shave DFUS [Galal et., 2021].

The most serious type of diabetes is type 2 diabetes, more than 95% of people with diabetes have type 2 diabetes. Type 2 diabetes was formerly called non-insulin dependent, or adult onset. Until recently, this type of diabetes was seen only in adults but it is now also occurring increasingly frequently in children, Symptoms of type 2 diabetes can be mild. They may take several years to be noticed. Symptoms may be similar to those of type 1 diabetes but are often less marked. As a result, the disease may be diagnosed several years after onset, after complications have already arisen

The most serious complication of type 2 diabetes is ischemic diabetic foot which is related to the types of diabetic foot ulcer (DFU), where the ischemic diabetic foot is unfortunately responsible for about three quarters of non-traumatic amputations [Callaghan et al.,2012].

More the 1 million of diabetes patients undergo a lower limb amputation per year, about 6% of these patients reach to IC at hospitals, as a result of infection and sepsis from IDF

The commonest type of diabetic neuropathies is that which effects nerves in the feet and legs and is usually known as peripheral neuropathy which can result in a loss of foot sensation, increasing the risk of unrecognized foot injuries and sores due to lack of sensation leading to amputation.

Management of diabetic foot ulcers (DFU) is a long and complex process that begins before ulcer formation through a program of prevention. It has been reported that the prevalence of DFU in the hospitalized patient ranging is from 4 to 10 % and the risk of patients with diabetes developing a foot ulcer in their lifetime could be as high as 25 % [Boulton & Vileikyte, 2008]. Early assessment of DFU in people with diabetes is crucial and still remains a difficult challenge for clinician.

Complications of foot ulcers are the major cause of hospitalization and amputation in the people with diabetes leading to significant health care costs as evidenced by the fact that 20 – 40 % of health care resources are spent on diabetes-related diabetic foot [Armstrong DG , Lavery LA et al., 2005]

Since prevention is more cost-effective than the treatment of diabetes complications, there is indeed a pressing need for more evidence to support efficacious preventive strategies that could delay or avert the development and

progression of microvascular, macrovascular complications in diabetic populations, especially diabetic foot [Alice & Juliana 2015].

It is therefore crucial to find effective markers for assessment of disease severity and also for the tailoring of therapy. Although clinical and laboratory indices are used to assess disease severity in patients with diabetic foot, a great number of methods have also been investigated for DFU diagnosis and determination of disease severity [M. Demetriou et al., 2013].

In this study, we compared the level of endocan which is(the pro inflammatory marker & an endothelial marker) in diabetes & their complications . [Zhang J. 2022;23] and the level of taurine which is (an immunological marker).

Endocan as an inflammatory endothelial biomarker has been shown to increase in several communicable and non-communicable diseases &the level of serum endocan is significantly increased in patients with diabetes compared to non-diabetic controls. Patients with T2DM also have increased levels of endocan compared with healthy controls. Besides, endocan levels in neuropathy, retinopathy, or cardiovascular diseases are higher than in diabetic patients without these complications. Overall, it seems that endocan might be a possible suitable candidate for the assessment of endothelial dysfunction in diabetic patients.IN The pathophysiology of peripheral artery disease (PAD) includes an inflammatory, atherosclerotic and hypercoagulable state involving vascular endothelial cells, vascular smooth muscle cells and inflammatory cells [Dakhel A, Engstro¨m G, Melander O, et al. 2021] Biomarkers can be used to evaluate different stages of this process caused by endothelial and macrovascular dysfunction . It is of potential relevance to assess the role of endocan in patients with PAD (e.g. in predicting stent or graft restenosis or risk of amputation).

At the molecular level, endocan is a soluble proteoglycan primarily released by endothelial cells. Its expression is up-regulated by inflammatory markers, including tumor necrosis factor-α (TNF-α) and interleukin (IL)-1β, which in turn leads to the higher expression of vascular cell adhesion molecule 1 (VCAM-1) and intercellular adhesion molecule 1 (ICAM-1); leukocyte migration and inflammatory response are the result of the higher expression of these cell adhesion molecules. In line, endocan levels are also elevated in other conditions, such as malignancies, inflammatory diseases, hypertension, atherosclerosis, carotid artery disease, peripheral artery disease, and sepsis [Balta S ,2015,2021]. Therefore, it is not surprising that it is increased in diabetes due to its inflammatory role same as other diseases.

Another rationale by which endocan might be increased is endothelial dysfunction observed in diabetes as well as other diseases. Increased plasma levels of endocan are thought to be a possible immuno-inflammatory marker that may represent endothelial activation and dysfunction and may be linked to diseases causing endothelial damage like diabetes. Based on experimental and clinical studies, there is a link between insulin resistance and endothelial dysfunction, for which newer anti-diabetic agents are modified to target it . Moreover, since atherosclerotic events are one of the main pathways diabetes can affect health, considering the highlighted role of the endothelium in its progression, endocan could be suggested as a prognostic biomarker.

Data suggested that patients with ischemic diabetic foot have higher serum endocan level (more than 350 pg/ ml) than control diabetic patients (more than 250 pg/ml) but serum endocan level in the frank healthy people is (59 -210 pg/ml).

Different physiological functions and roles are modulated by taurine among these are: anitioxidation; osmoregulation; membrane stabilization; conjugation of bile acids; neuromodulation; detoxification; and regulation of calcium homeostasis. Clinically, prophylactic and therapeutic taurine supplementation showed a beneficial effectiveness in a broad spectrum of oxidative stress-induced pathologies and clinical conditions including: hepatotoxicity and hepatic disorders, renal disorders, and diabetes mellitus [Oja & Saransaari, 2007; Yamori et al., 2010].

In recent years, studies on taurine found that it played a protective role in diabetes mellitus & its complications, that we show when we found various tissue dysfunctions have been associated with taurine depletions from these tissues , so the lack or decrease of taurine is considered as a major factor in the production of symptoms and complications of these illnesses [El-Agouza, 2000; El-Agouza et al., 2011].

Taurine has been found to suppress the secretion of cytokines that are related to diabetes, including TNF-α and MCP-1. These cytokines are known to play a role in the development and progression of diabetes. By suppressing their secretion, taurine helps to reduce the risk or severity of diabetes [Endocrinology and Metabolism 2023].

Taurine has been found to influence blood glucose level as well as insulin levels, and it may also be involved in the functioning and the integrity of pancreatic beta cells [Chang & Kwon, 2000; Lee et al., 2004]. Kulakowski and Maturo provided results to support their hypothesis that hypoglycemic properties of taurine are mediated through an

interaction of taurine with the insulin receptor [Kulakowski & Maturo, 1990]. Both type 1 and type 2 diabetes have been associated with an increased level of oxidative stress [Maritim et al., 2003].

Data suggested that patients with ischemic diabetic foot have lower serum taurine level (<20 μ.mol /l) than controlled diabetic patients where the serum taurine level is (>35μ.mol/l)but the range in the frank people is (55 -80 μ.mol /l) [EL Agouza et al., 2011; Agouza &El Nasher ,2011] .

5. Conclusion

In our study, we found the inverse relation between the serum endocan & the serum taurine in type 2 diabetic patients with ischemic diabetic foot where endocan level elevated according to the degree of inflammation contrary, taurine level is decreased parallel to the degree of the inflammatory foot.

So, our recommendation for all diabetic patients measuring the level of both serum endocan &taurine at least every 3 to 6 months to detect any early diagnostic of ischemic diabetic foot complications, to minimize the rate of mortality and the amputation.

Compliance with ethical standards

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Disclosure of conflict of interest

No conflict of interest to be disclosed.

Statement of ethical approval

The studies involved use of human subject, the author declare that the ethical approval was taken from GOTHI, National Institute of Diabetes and Endocrinology, Ministry of Health, Egypt.

Statement of informed consent

The author declares that informed consent was obtained from all individual participants included in the study.

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