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# Marked Weight Loss, Muscle Wasting and Fatigue on Administration of Empagliflozin in a Subject with Type 2 Diabetes

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***Author's contribution***

*The sole author designed, analyzed and interpreted and prepared the manuscript.*

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***Case Report***

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## ABSTRACT

**Background:** Weight loss, fatigue and decreased quality of life are frequently reported at the time of initial diagnosis by subjects with Diabetes Mellitus of both types although far more frequently with type 1 and are attributed to fluid and electrolyte losses due to persistent glycosuria as well as decline in adipose tissue secondary to lipolysis. However, muscle wasting and weakness as initial manifestations are noted almost exclusively in subjects with type 1 diabetes.
**Case Report:** A man with history of type 2 diabetes about 10 years reported onset of general fatigue, polyuria, nocturia, polydipsia as well as profound progressive weight loss, muscle wasting and weakness within 2 weeks after initiation of Empagliflozin. He had been receiving glimepiride 8 mg and metformin 2000 mg daily for about 5.5 years. Resolution of polyuria, nocturia and polydipsia was attained promptly within a week after discontinuation of Empagliflozin and initiation of insulin glargine. Weight gain and improvement in fatigue began by 2 weeks, continued until achieving desirable glycemic control over next 4 months and then stabilized. However, muscle mass and strength have not yet returned to the level prior to initiation of Empagliflozin during the follow up period of 12 months.

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**Conclusion:** Empagliflozin is responsible for induction of transient weight loss as well as persistent muscle weakness and wasting in this subject.

*Keywords: Type 2 diabetes; empagliflozin; muscle wasting; myopathy; osteopenia.*

## 1. INTRODUCTION

Weight loss, dizziness, fatigue, polyuria, nocturia, polydipsia and decreased quality of life are frequently reported at the time of initial diagnosis by subjects with Diabetes Mellitus of both types [1-4]. Weight loss, dizziness and fatigue are attributed to onset of dehydration secondary to fluid and electrolyte losses due to persistent glycosuria as well as decline in adipose tissue secondary to lipolysis. Muscle wasting and weakness as initial manifestations occur almost exclusively in subjects with type 1 diabetes and have not been reported in subjects with type 2 diabetes [1-4]. Herein, I report a man with type 2 diabetes presenting with profound progressive weight loss, muscle wasting and weakness as well as general fatigue within 2 weeks after initiation of Empagliflozin. Moreover, I believe that Empagliflozin is responsible for these manifestations secondary to markedly increased ongoing gluconeogenesis from the muscle protein and concurrent breakdown of muscle glycogen stores induced by hyperglucagonemia as a compensatory response to glycosuria promoted by Empaglliflozin via SGLT2 inhibition.

## 2. CASE REPORT

59 year old Caucasian man was referred to Endocrinology clinic at Central Iowa Veterans Health Care System in Des Moines, Iowa, USA because of progressive fatigue, tiredness, weight loss of 8 kg. and weakness for duration of 2 months since he started taking Empagliflzin for control of his blood sugar in addition to the combination of Metformin 2000 mg and Glimepiride 8 mg daily which he had used for almost 5 years without experiencing any of the well described adverse effects such as abdominal pain, nausea, vomiting or diarrhea. He also related onset of polyuria, polydipsia and marked nocturia contributing to feeling of tiredness in the morning due to lack of adequate sleep because of awakening to urinate several times during night. He also complained of dysuria. On further interrogation, he reported that he could not pull out the small twin engine plane out of the hanger for the last 4 weeks that he was able to do for over 20 years as a part of his work as a pilot. He also claimed that his 'arm and thigh muscles had gotten smaller but without ache or pain or twitching'. He reported no hospitalizations for acute or chronic illness or major or minor surgery for almost 15 years. Neither was he hospitalized any time for diabetes during 10 years since diagnosis. He reported fracture of right fibula with a complete recovery about 3.5 years prior to this visit. His present medications included Lisinopril, 10 mg daily for hypertension for about 7 years, Atorvastatin, 40 mg daily for dyslipidemia and Aspirin 81 mg daily for prevention of cardiovascular events since the diagnosis of diabetes. He had never smoked and consumed alcohol occasionally at social events approximately once every 3-4 months. Family history documented his father suffering from type 2 diabetes with the demise at the age of 66 years following an acute coronary event. Rest of the family history was noncontributory. He denied ingestion of over the counter supplements or illicit drugs.

Physical examination revealed an alert, oriented, afebrile elderly gentleman in no acute distress. Pulse rate and blood pressure were 76 per minute and 118/78 mm Hg in supine position and changed to 92 per minute and 102/65mm Hg on standing documenting presence of orthostasis. Body weight was 87 kg. Neurological examination showed decreased power and restricted voluntary movements of muscles of both arms, especially deltoids, biceps and triceps as well as buttocks and thighs. Variable wasting of these muscles was also evident though without fasciculations. Sensations were intact bilaterally in both upper and lower extremities including fingers and toes. Deep tender reflexes in both upper and lower extremities including ankles were present. No signs of inflammation were noted in extremities. Rest of systemic examination including ear, nose and throat, lungs, heart, abdomen, peripheral circulation as well as rectal examination was normal.

Laboratory tests showed normal complete blood count and serum creatinine, chloride C-reactive protein, liver enzymes, total protein, free T4, TSH, free testosterone as well as FSH, LH and prolactin levels. Fasting plasma glucose, HbA1c

and serum concentrations of urea nitrogen, sodium, potassium, calcium, phosphorus, uric acid and CK (78% mm fraction) were elevated whereas serum bicarbonate ($HCO_3$) was decreased (Table 1). Fasting serum c-peptide concentration was 2.86 ng/ml with simultaneous glucose level of 146 mg/dl. Serum betahydroxybutyrate was increased (8.6 with normal value of < 4.5 mM/l) resulting in elevated anion gap. Simultaneously determined arterial blood gas showed $PCO_2$, 30 mm Hg; $PO_2$, 96 mm Hg and pH, 7.36. Chest X Ray, Electrocardiogram, EMG and Nerve conduction studies were all normal. Urinalysis revealed glycosuria with ketonuria, microalbuminuria, specific gravity > 1030, positive leukocytes esterase and nitrite testing as well as RBCs, 5-10 and WBCs, 20-25 with no epithelial cells. Urine culture was positive for E.Coli. 24 hour urine excretion of multiple metabolites was determined (Table 2).

Based on the history, physical examination and the laboratory tests, the diagnoses of dehydration, urinary tract infection, proximal myopathy and uncontrolled diabetes with ketoacidosis were established. Empagliflozin was promptly discontinued because of presence of dehydration, hyperkalemia, ketonuria, ketonemia and urinary tract infection,

**Table 1. Determinations of HbA1c, fasting plasma glucose, serum electrolytes and other pertinent chemistries prior to discontinuation of Empagliflozin (1st Visit) and following administration of insulin Glargine at 6 and 12 months**

| | 1st visit | 6 months | 12 months |
|---|---|---|---|
| HbA1c (%) | 7.6 | 7.4 | 7.1 |
| Glucose (mg/dl) | 173 | 148 | 105 |
| Sodium (mM/l) | 146 | 142 | 140 |
| Potassium (mM/l) | 5.3 | 4.3 | 4,4 |
| Chloride (mM/l) | 104 | 102 | 103 |
| $HCO_3$ (mM/l) | 19 | 30 | 28 |
| Anion Gap | 23 | 10 | 9 |
| Creatinine (mg/dl) | 0.64 | 0.70 | 0.72 |
| Urea Nitrogen (mg/dl) | 21 | 13 | 12 |
| Urea Nitrogen/Creatinine | 32.8 | 18.5 | 16.6 |
| Calcium (mg/dl) | 10.6 | 9.5 | 9.2 |
| Phosphorus (mg/dl) | 5.2 | 4.1 | 4.3 |
| Uric acid (mg/dl) | 7.2 | 6.2 | 6.4 |
| Cholesterol (mg/dl) | 168 | 135 | 128 |
| Triglycerides (mg/dl) | 152 | 142 | 115 |
| HDL Cholesterol (mg/dl) | 31 | 36 | 39 |
| LDL cholesterol (mg/dl) | 108 | 72 | 65 |
| Hemoglobin ( g) | 15.8 | 14.8 | 14.7 |
| Hematocrit (%) | 49 | 44 | 44 |
| CK (Units) | 462 | 314 | 294 |

**Table 2. Determinations of 24 hour urine volume (UV) and excretion of pertinent products prior to discontinuation of Empagliflozin (1st visit) and following administration of insulin Glargine at 6 and 12 months**

| | 1st visit | 6 months | 12 months |
|---|---|---|---|
| UV (ml) | 3400 | 2350 | 1680 |
| Glucose (g) | 35 | 3 | 0.2 |
| Ketone (mg) | 270 | Negative | Negative |
| Sodium (mM) | 260 | 119 | 128 |
| Potassium (mM) | 80 | 64 | 72 |
| Creatinine (mg) | 1834 | 1234 | 1140 |
| Urea Nitrogen (mg) | 1113 | 766 | 782 |
| Microalbumin (mg) | 386 | 260 | 120 |
| Calcium (mg) | 268 | 236 | 220 |
| Phosphorus (mg) | 620 | 284 | 304 |
| Uric Acid (mg) | 650 | 534 | 548 |

which are well established adverse effects of the drug [5-28]. Instead, s.c administration of insulin Glargine 20 units (0.2 units/kg) in AM was initiated while continuing Metformin and Glimepiride for treatment of hyperglycemia with instructions to increase daily dose by 2 units every 3 days until AM blood sugar< 130 mg/ dl was attained according to recommendations by American Diabetes Association [29]. Oral Antibiotic therapy with Levoquin 500 mg daily was begun to manage urinary tract infection. Patient was also advised to consume daily at least 2.0 liters of fluids without containing sugar to combat dehydration and was counseled by diabetes educator regarding symptoms of hypoglycemia with steps to correction and implementation of life style intervention including appropriate diet and exercise. Finally, he was scheduled to return for a follow up clinic visit in 2 weeks. At this visit, patient reported improvement in fatigue and resumption in weight gain with resolution of polyuria, nocturia and dysuria as well as orthostasis. However, he still complained of lack of improvement in muscle strength and wasting. Previous abnormal laboratory tests normalized confirming remission of dehydration and urinary tract infection (Tables 1 and 2), the exception being CK which declined but did not normalize (Table 1). Average AM blood sugar over 3 days prior to visit was 148 mg/ dl while injecting 28 units of insulin Lantus without onset of symptoms of hypoglycemia indicating improvement in hyperglycemia. Patient was advised to continue increasing the daily dose of Lantus as recommended at the initial visit and encouraged to be compliant with diet, exercise and medications. So far, patient has returned for follow up visits at interval of 3 months for a year. Body weight returned to 95 kg at 6 months and stabilized with a sustained complete recovery from fatigue and symptoms of hyperglycemia, e.g. polyuria, nocturia, polydipsia, dizziness etc. at the last visit. However, he continues to report ' inability to pull the plane out of hanger' and thus the lack of improvement in muscle strength and muscle wasting although he denies progression of muscle wasting. Physical examination has confirmed the continued presence of wasting and diminished strength in the proximal muscles noted at the initial visit. Glycemic control improved by 3 months and attained the desirable range by 6 months and has remained till the last visit. All other laboratory tests including urine urea nitrogen and creatinine normalized by 6 months and remained normalized at the last visit (Tables 1 and 2).

## 3. DISCUSSION

The subject in this report presented weight loss with muscle wasting and declining muscle strength within 4 weeks after initiation of Empagliflozin despite lack of lapse of glycemic control. These manifestations are almost always reported by subjects with type 1 diabetes and rarely described by subjects with type 2 diabetes either at initial diagnosis or during the period of lapse of glycemic control [1-4]. Moreover, both the weight loss and the muscle disorder remained progressive until discontinuation of Empagliflozin and initiation of insulin glargine. Body weight has been regained on attaining desirable glycemic control over 6 months and stabilized on maintenance of glycemic control over 12 months as previously described in subjects with type 1 diabetes [1-4]. However, the subject has continued to report lack of improvement in muscle strength also evident by no change in muscle mass with apparent stabilization of muscle wasting without further progression consistent with lowering of CK without normalization.

Weight loss in this subject is consistent with the data in the literature [5-12]. Variable weight loss is documented to occur in subjects with type 2 diabetes following treatment with all SGLT2 inhibitors [5-12]. The mechanism of weight loss is not well established though may be attributed to dehydration due to urinary loss of fluids induced by glycosuria. Moreover, concurrent urinary loss of calories as a result of persistent glycosuria is also likely to be a contributing factor. Finally, hyperglucagonemia despite presence of circulating insulin in type 2 Diabetes as documented in our subject or insulinopenia in type 1 diabetes may promote weight loss and muscle wasting by promoting lipolysis, gluconeogenesis and glycogenolysis. However, the contribution of individual body constituents e.g. adipose tissue and muscle mass in subjects administered SGLT2 inhibitors is not documented.

Administration of SGLT2 inhibitors is well documented to induce rise in plasma glucagon [26-28,30] and thus may exacerbate hyperglucagonemia already present with uncontrolled hyperglycemia in subjects with both type 1 and type 2 diabetes [31-33]. Moreover, physiologic role of hyperglucagonemia in enhancing lipolysis and gluconeogenesis via breakdown of protein fractions from both muscles and bones is well established [1-4,31-

36]. Therefore, it is apparent the decline both the adipose tissue and the muscle mass contributes to weight loss following treatment with these agents including Empagliflozin as documented in the subject in this report. These manifestations of muscle involvement could not be attributed to insulinopenia in our subject since serum c-peptide concentration was adequate and appropriate in relation to simultaneously determined plasma glucose level. Neither are they likely to be caused by any other endocrine or metabolic disorder as documented by appropriate laboratory testing. Finally, it is extremely unlikely that atorvastatin contributed to muscle wasting or weakness for several reasons: 1) Subject never manifested any form of muscle disorder during several years while receiving atorvastatin; 2) A major manifestation of statin induced muscle disorder is pain or discomfort and not wasting; 3) Occurrence of muscle disorder during administration of statin is often attributed to a high circulating statin concentration induced by addition of another drug metabolized by the same pathway as statin; 4) Empagliflozin is not metabolized by the same mechanism as a statin and hence is unlikely to raise circulating atorvastatin concentration leading to statin induced myopathy especially in absence of pain but with wasting; 5) A prompt withdrawal of Empagliflozin prevented further progression of both, muscle wasting and decline in strength as noted at the last visit at 12 months. However, recovery from fatigue accompanied by lowering of serum CK level may indicate improvement of the muscle disorder. It is plausible that a longer period may be required for regaining of muscle strength and muscle mass after the insult by a prolonged administration of Empagliflozin for several months. Therefore, lack of documentation of any other cause of muscle disorder by extensive laboratory testing and the nature of the course of manifestations implicate Empagliflozin as a lone contributor playing a definite and a distinct role in the presentation in our subject. Moreover, decline in bone mass, osteopenia (T score, -1.8 in the lumbar spine and -1.6 at left hip) documented in this subject may be attributed to Empagliflozin as well since onset of osteoporosis has been reported on administration of these drugs [37,38].

## 4. CONCLUSION

Therefore, it is concluded that the weight loss was induced by Empagliflozin as has been well documented. I believe that the muscle weakness and wasting as well as osteopenia were also caused by Empagliflozin in this subject based on the aforementioned pathophysiologic mechanism.

## CONSENT

It is not applicable for this study.

## ETHICAL APPROVAL

It is not applicable for this study.

## COMPETING INTERESTS

Author has declared that no competing interests exist.

## REFERENCES


1. Lohiya S, Kreisberg R, Lohiya V. Recurrent diabetic Ketoacidosis in two community teaching hospitals. Endocr Pract. 2013;19(5):829-833.
2. Maletkovic J, Drexler A. Diabetic ketoacidosis and hyperglycemic hyperosmolar state. Endocrinol Metab Clin North Am. 2013;42(4):677-695.
3. Nyenwe EA, Kitabchi AE. The evolution of diabetic ketoacidosis: An update of its etiology, pathogenesis and management. Metabolism. 2016;65(4):507-521
4. Acharya R, Kabadi U. Endocrinology, diabetes & metabolism case reports, 02 2017, EDM160123, 10.1530/EDM-16-0123.
5. Kabadi UM. How low do we fall to lower hemoglobin A1c? SGLT2 Inhibitors: Effective Drugs or Expensive Toxins! Journal of Diabetes Mellitus. 2013;3(4): 199-201.
6. Riser T, Harris K. The clinical efficacy and safety of sodium glucose cotransporter-2 inhibitors in adults with type 2 diabetes mellitus. Pharmacotherapy. 2013;33:984-999.
7. Tahrani AA, Barnett AH, Bailey CJ. SGLT inhibitors in management of diabetes. Lancet Diabetes Endocrinol. 2013;1(2): 140-151.
8. Lamos EM, Younk LM, Davis S. Canagliflozin, an inhibitor of sodium-glucose cotransporter 2, for the treatment of type 2 diabetes mellitus. Expert Opin Drug Metab Toxicol. 2013;9(6):763-775.
9. Vasilakou D, Karagiannis T, Athanasiadou E, Mainou M, Liakos A, et al. Sodium-

glucose cotransporter 2 inhibitors for type 2 diabetes: A systematic review and meta-analysis. Ann Intern Med. 2013;159(4): 262-274.

10. Foushee JA, Goodbar NH, Kelly JL, Clarke SL. Cerebrovascular accident in a high-risk patient during the early initiation phase with canagliflozin. Ann Pharmacother. 2014;48(8):1066-1069.
11. Kaku K, Watada H, Iwamoto Y, Utsunomiya K, Terauchi Y, et al. Tofogliflozin 003 study group. Efficacy and safety of monotherapy with the novel sodium/glucose cotransporter-2 inhibitor tofogliflozin in Japanese patients with type 2 diabetes mellitus: A combined Phase 2 and 3 randomized, placebo-controlled, double-blind, parallel-group comparative study. Cardiovasc Diabetol. 2014;13:65-104.
12. Vivian EM. Dapagliflozin: A new sodium-glucose cotransporter 2 inhibitor for treatment of type 2 diabetes. Am J Health Syst Pharm. 2015;72(5):361-372.
13. EMA reviews diabetes medicine canagliflozin. Review Follows Data on Toe Amputations in Ongoing Study; 2015.
14. FDA Drug Safety Communication. Interim clinical trial results find increased risk of leg and foot amputations, mostly affecting the toes, with the diabetes medicine canagliflozin (Invokana, Invokamet); FDA to investigate; 2016. (FDA What's New: Drugs, 05/19/2016).
15. Hinnen D. Glucuretic effects and renal safety of dapagliflozin in patients with type 2 diabetes. Ther Adv Endocrinol Metab. 2015;6(3):92-102.
16. FDA Drug Safety Communication 2016 FDA strengthens kidney warnings for diabetes medicines canagliflozin (Invokana, Invokamet) and dapagliflozin (Farxiga, Xigduo XR).
17. Kabadi UM. SGLT2 inhibitors: Far too many cautions and alerts and limited efficacy. J Diabetes Metab Disord Control. 2016;3(5):00077.
    DOI: 10.15406/jdmdc.2016.03.00077
18. Nyirjesy P, Zhao Y, Ways K, Usiskin K. Evaluation of vulvovaginal symptoms and Candida colonization in women with type 2 diabetes mellitus treated with canagliflozin, a sodium glucose co-transporter 2 inhibitor. Curr Med Res Opin. 2012;28(7): 1173-1178.
19. Nicolle LE, Capuano G, Ways K, et al. Effect of canagliflozin, a sodium glucose co-transporter 2 (SGLT2) inhibitor, on bacteriuria and urinary tract infection in subjects with type 2 diabetes enrolled in a 12-week, phase 2 study. Curr Med Res Opin. 2012;28(7):1167-1171.
20. Johnsson KM, Ptaszynska A, Schmitz B, Sugg J, Parikh SJ, et al. Urinary tract infections in patients with diabetes treated with dapagliflozin. J Diabetes Complications. 2013;27(5):473-478.
21. Johnsson KM, Ptaszynska A, Schmitz B, Sugg J, Parikh SJ, et al. Vulvovaginitis and balanitis in patients with diabetes treated with dapagliflozin. J Diabetes Complications. 2013;27(5):479-484.
22. Kaur A, Winters SJ 2015 Severe hypercalcemia and hypernatremia in a patient treated with canagliflozin. Endocrinol Diabetes Metab Case Rep.
23. Peters AL, Buschur E, Buse JB, Cohan P, Diner JC, et al. Euglycemic diabetic ketoacidosis: A potential complication of treatment with sodium-glucose cotransporter 2 inhibition. Diabetes Care. 2015;38(9):1687-1693.
24. Peters AL, Henry RR, Thakkar P, Tong C, Alba M. Diabetic ketoacidosis with canagliflozin, a sodium-glucose cotransporter 2 inhibitor, in patients with Type 1 diabetes. Diabetes Care. 2016;39(4):532-538.
25. FDA Drug Safety Communication. FDA revises labels of SGLT2 inhibitors for diabetes to include warnings about too much acid in the blood and serious urinary tract infections; 2015.
26. In brief: Ketoacidosis with SGLT2 inhibitors. Med Lett Drugs Ther. 2015;57(1471):94.
27. Taylor SI, Blau JE, Rother KI. SGLT2 Inhibitors may predispose to ketoacidosis. J Clin Endocrinol Metab. 2015;100(8): 2849-52.
28. Kalra S, Sahay R, Gupta Y. Sodium glucose transporter 2 (SGLT2) inhibition and ketogenesis. Indian J Endocrinol Metab. 2015;19(4):524-8.
29. American Diabetes Association. Pharmacologic approaches to glycemic treatment. Diabetes Care. 2017;40(Supple 1):S64-S74.
30. Sargent J. Therapy: SGLT2 inhibitor dapagliflozin promotes glucagon secretion in α islet cells. Nat Rev Endocrinol. 2015;11(7):382.
31. Müller WA, Faloona GR, Unger RH. Hyperglucagonemia in diabetic

ketoacidosis. Its prevalence and significance. Am J Med. 1973;54(1):52-7.
32. Kabadi UM. Hepatic regulation of pancreatic alpha-cell function. Metabolism. 1973;42(5):535-543,
33. Lee YH, Wang MY, Yu XX, Unger RH. Glucagon in type 2 DM Glucagon is the key factor in the development of diabetes. Diabetologia; 2016. [Epub ahead of print]
34. Hudec SM, Camacho PM. Secondary causes of osteoporosis. Endocr Pract. 2013;19(1):120-128.
35. Tsentidis C, Gourgiotis D, Kossiva L, Doulgeraki A, Marmarinos A, et al. Higher levels of s-RANKL and osteoprotegerin in children and adolescents with type 1 diabetes mellitus may indicate increased osteoclast signaling and predisposition to lower bone mass: a multivariate cross-sectional analysis. Osteoporos Int. 2016; 27(4):1631-1643.
36. Rathmann W, Kostev K Fracture risk in patients with newly diagnosed type 2 diabetes: A retrospective database analysis in primary care. J Diabetes Complications. 2015;29(6):766-770.
37. Taylor SI, Blau JE, Rother KI. Possible adverse effects of SGLT2 inhibitors on bone. Lancet Diabetes Endocrinol. 2015;3(1):8-10.
38. FDA Invokana and Invokamet (canagliflozin): Drug safety communication - New Information on Bone Fracture Risk and Decreased Bone Mineral Density; 2015. [Posted 09/10/2015]



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