CASE REPORT

Thyroid dysfunction following a kelp-containing marketed diet

Tiziana Di Matola,¹ Pio Zeppa,² Maurizio Gasperi,³ Mario Vitale²¹A.O.R.N. dei Colli Hospital, Naples, Italy²University of Salerno, Baronissi, Salerno, Italy³University of Molise, Campobasso, Italy

Correspondence to

Mario Vitale,
mavitale@unisa.it

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SUMMARY

Complementary medications and herbal medicine for weight loss have become very popular. We report a case of thyroid dysfunction following the ingestion of a kelp-containing marketed diet in a 45-year-old woman with no previous thyroid disease. Signs of hyperthyroidism occurred shortly after a kelp-containing diet. Hyperthyroidism lasted 2 months and was followed by an overt hypothyroidism. The thyroid scintiscan exhibited an extremely low uptake and colour-Doppler ultrasonography revealed multiple small areas of pulsatile flow. After 3 months of levothyroxine substitutive therapy, normal thyroid function was recovered after levothyroxine discontinuation. This clinical history is compatible with a case of iodine-induced thyrotoxicosis followed by prolonged block of the sodium–iodide symporter activity as a consequence of excessive iodine consumption from kelp. Consumers of marketed diets containing kelp or other iodine-rich ingredients should be advised of the risk to develop a thyroid dysfunction also in the absence of underlying thyroid disease.

BACKGROUND

The rising obesity epidemic is a worldwide high priority public health issue. Less calories intake and more exercise are often insufficient to overweight and obese to achieve a satisfactory weight loss. Complementary and alternative medicine for weight loss has never been more popular. Although dietary supplements marketed for weight loss are available in pharmacies, health food stores and on the Internet, most of these products have not been proven effective and some are dangerous. We report a case of thyroid dysfunction due to the consumption of a kelp-containing marketed diet. Kelp is a type of seaweed known for its rich iodine content. In some individuals, the high iodine load can result in thyroid dysfunction. Hypothyroidism or hyperthyroidism can be either subclinical or overt, transient or sometimes persistent.¹

CASE PRESENTATION

A 45-years-old woman presented to the outpatient clinic for mild anterior neck pain. Her medical history and family history were unremarkable. Previous endocrine tests revealed thyroid hormones and thyroid-stimulating hormone (TSH) plasma levels within the normal range and absence of thyroid autoimmunity. A detailed medical history revealed that 1 month before, she self-treated to weight loss for a period of 10 days by a nutrition product (Starguo Menu, Beijing Green World

Nutrition Health Products Co, Ltd, Beijing, China; box 1).

INVESTIGATIONS

At our first observation, she was 62 kg, 155 cm tall (body mass index 27.5), with clinical signs of hyperthyroidism: regular pulse of 90 bpm, warm moist skin, trembling hands, anxiety and insomnia. Physical examination confirmed an enlarged thyroid, slightly painful at palpation. All haematological parameters and sedimentation rate were in the normal ranges. The hormonal profile was of overt hyperthyroidism, antithyroid peroxidase and antithyroglobulin antibodies were negative (table 1).

The patient refused to take medications. Twenty days later, signs of hyperthyroidism and biochemical hyperthyroidism were more evident. Ultrasonography revealed a slightly enlarged gland with heterogeneous pattern diffusely hypoechoic (figure 1A). Nodules were not present. By colour-Doppler the gland showed multiple small areas of pulsatile flow diffusely throughout the gland (thyroid inferno; figure 1B). One month later, the patient complained of cold intolerance, dry skin, sleepiness, weakness and depression. Hormonal profile was of overt hypothyroidism with absent thyroid antibodies. Ten days later the clinical symptoms persisted, colour-Doppler ultrasonography revealed a normal intrathyroidal blood-flow (figure 1B). ⁹⁹mTc thyroid scintiscan exhibited an extremely low uptake (figure 2). Urinary iodine was in the normal range (80 ng/L).

DIFFERENTIAL DIAGNOSIS

The modest thyroid pain at palpation could suggest the occurrence of a subacute thyroiditis. However, thyroid pain at palpation is compatible with the fast thyroid enlargement. The ultrasound feature of ‘thyroid inferno’ is not typical of subacute thyroiditis, while it has been documented to occur after an excessive iodine load.

TREATMENT

A substitutive therapy with oral levothyroxine (L-T4) at 1.2 µg/kg/day was initiated, followed by reliefs of all hypothyroid symptoms in 10 days. L-T4 therapy was discontinued after 80 days and thyroid status was reevaluated.

OUTCOME AND FOLLOW-UP

Endocrine tests revealed thyroid hormones and TSH in the normal range and the absence of antithyroid antibodies.

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Box 1 Components of STARGUO MENU*

Soy flour
 Black beans
 Shallot
 Black sesame
 Buckwheat flour
 Skim milk powder
 Barley sprouts
 Cornmeal
 Oatmeal
 Chinese jujube
 White beans
 Lotus seeds
 Mushroom (*Lentinus edodes*)
 Almonds
 Seaweed (kelp)
 Salt
 Ginger
 Soya phospholipids
 Calcium carbonate

*The daily dose was 60 g, containing about 1800 µg iodine.

DISCUSSION

We describe a case of dysfunction following the ingestion of a marketed diet containing natural components, including kelp, a type of seaweed known for its rich iodine content and *Lentinus edodes* also known as 'shiitake mushroom' or 'black forest mushroom'. Eritadenine, an adenosine analogue alkaloid isolated from *L. edodes*, has been shown to reduce cholesterol levels, whereas some polysaccharides present in this type of mycete, displayed some anti-inflammatory activity. These compounds do not have recognised effects on thyroid function.

Kelp is a type of seaweed known for its rich iodine content, available as a dietary supplement marketed for thyroid support. Iodine content in kelp varies depending on harvest location and preparation. Its average iodine content has been estimated to be about 1500 µg/g of dried preparation.²

The normal thyroid gland of human adults secretes about 50 µg iodine daily, an amount the gland can take up in a dietary iodine intake between 100 and 150 mg per day. Iodine excess may be tolerated or may induce thyroid disease with hypothyroidism or hyperthyroidism with or without goiter and autoimmunity. Most individuals with a normal thyroid gland tolerate large iodine excess, maintaining thyroid hormones

within the normal range, although serum fT4 and fT3 can usually be moderately reduced, TSH increased and a small goiter can develop.^{3,4}

The thyroid gland reacts to excess iodine intakes by different mechanisms the most important of which are the Wolff-Chaikoff effect, the down expression of the sodium-iodide symporter (NIS), and the block of hormone secretion from stores. The thyroid gland accumulates iodide from plasma against a concentration gradient up to 1:80. This iodide accumulation is made possible by the NIS that transports two sodium cations and one iodide anion across the basal cell membrane from the exterior into the interior of the cell.⁵ TSH strictly regulates NIS expression so that in iodine deficiency, TSH increases and in turn TSH gene expression is increased.⁶ In 1948, Wolff and Chaikoff reported that elevated plasma iodide levels was followed by a decreased organic binding of iodide in the thyroid.⁷ This effect (acute Wolff-Chaikoff effect) was of short duration and escape occurred in approximately 2 days, in the presence of continued high plasma iodide concentrations. The mechanism responsible for the acute Wolff-Chaikoff effect remains unknown and has been hypothesised to be caused by organic iodocompounds formed within the thyroid.⁸

Following the escape from the acute Wolff-Chaikoff effect, the biosynthesis of NIS can be shut down by a TSH-independent mechanism. Chronic excess iodide in rat FRTL-5 thyroid cells had no effect on NIS gene expression, whereas decreased NIS protein at a post-transcriptional level.⁹ In rats in vivo, excess iodide administration decreased both NIS mRNA and protein expression, by a mechanism that is at least in part, transcriptional.¹⁰ This mechanism has been proposed to account for the escape from the acute Wolff-Chaikoff effect. Excess iodine also blocks secretion of stored preformed hormone, as demonstrated in dog thyroid slices.¹¹ Large quantity of iodide can also have cytotoxic effects as shown in normal human thyroid cells in vitro where it induces apoptosis, through a mechanism involving generation of free radicals.¹² The normal thyroid gland adapts to iodine excess by these mechanisms so that most individuals tolerate a chronic excess of iodide without clinical symptoms.

Sometimes these mechanisms fail and iodine excess causes overt clinical hyperthyroidism or hypothyroidism. In some countries, iodine supplementation through iodised salt resulted in a significant number of cases of severe hyperthyroidism.^{13,14} Hyperthyroidism is most commonly encountered in regions of chronic iodine deficiency, in participants with long-standing nodular goiter and in hidden Graves' disease or toxic adenoma silent because of iodine deficiency. Other sources of excessive iodine are iodinated radio-contrast material and the antiarrhythmic drug amiodarone.¹⁵⁻¹⁷ An other source of excessive iodine

Table 1 Hormonal and antibody profile following STARGUO discontinuation

	fT3	fT4	TSH	Tg-Ab	TPO-Ab	L-T4
Normal range (days)	2–4 pg/mL	0.93–1.7 ng/dL	0.27–4.2 µUI/mL	<60 U/mL	<60 U/mL	
20	4.87	1.59	0.05	15	20	No
40	6.59	2.15	0.005			No
70	1.19	0.47	9.11			No
90	0.30	0.50	64.00	18	40	No
103	2.73	0.87	16.71			Yes
160	2.93	0.97	1.70			Yes
220	2.90	0.98	3.74	25	38	No

L-T4, indicates whether the patient was treated with levothyroxine 1.2 µg/kg/day.

Figure 1 Thyroid hormones and thyroid-stimulating hormone (TSH) profile. Hormones were measured after the indicated day from STARGUO discontinuation. The grey area indicates the treatment with L-T4. Normal ranges: fT3, 2–4 pg/mL; fT4, 0.93–1.7 ng/dL; TSH, 0.27–4.2 μIU/mL.

is dietary consumption of brown seaweed. Excessive iodine from kelp, a type of seaweed, has been described to adversely affect the thyroid.^{18 19} Kelp is available worldwide in grocery stores as it is a key ingredient of Japanese miso soup. It is also available as a dietary supplement in the form of capsules, powder and teas. Iodine-induced thyrotoxicosis has been reported after consuming a kelp-containing tea.²⁰ In that case, the patient suffered from multinodular goiter in an endemic

area of moderate iodine deficiency, that turned toxic after ingestion of the iodine-rich kelp and hyperthyroidism did not resolve spontaneously following discontinuation of the kelp-containing tea. The development of hypothyroidism with the negative metabolic effect of such a condition worsens the clinical situation of these participants. The reduced calories consumption, the reduction of psychic activities and the occurrence of depression, reduce the propensity of the participant to increase the exercise and determine the impossibility to obtain a weight loss even with an adequate reduction of calories intake. Failure to achieve a satisfactory weight loss may induce the hypothyroid participants to persist or even increase the consumption of the iodine-rich diet with the following worsening of the negative metabolic effects.

In our case, a participant with no evidence of pre-existing or underlying thyroid disease assumed for 10 days a daily dose of about 1800 μg iodine. Hyperthyroidism developed shortly, followed by overt hypothyroidism. In the acute hyperthyroid phase, the increased blood flow observed diffusely throughout the gland by colour Doppler ultrasonography, supports the occurrence of the Jod-Basedow phenomenon. The following hypothyroidism occurred about 2 months after diet discontinuation, was accompanied by inhibition of iodine uptake and normal urinary iodine secretion, suggesting a persistent downregulation of NIS. In general, escape from Wolff-Chaikoff effect is not achieved in patients with chronic systemic disease, euthyroid participants with Hashimoto's thyroiditis or Graves' disease treated with metimazole or propylthiouracil, while it is

Figure 2 Thyroid ultrasonography and scintigraphy. B-mode and colour-Doppler ultrasonography 40 days (A, B) and 80 days (C, D) after STARGUO discontinuation.

controversial whether normal participants can develop hypothyroidism when exposed to large iodine doses.²¹ The case we describe demonstrates that also in participants with normal thyroid status, a persistent, not definitive hypothyroidism can be induced by iodine excess. This clinical case calls for keen attention to avoid herbal medicine or diets for weight loss, containing kelp or other iodine-rich ingredients also in participants with no evidence of thyroid disease.

Learning points

- ▶ Iodine excess can cause overt clinical hyperthyroidism or hypothyroidism in participants with hidden thyroid disease.
- ▶ Also in participants with normal thyroid status, a persistent, not definitive hypothyroidism can be induced by iodine excess.
- ▶ Herbal medicine or diets for weight loss containing kelp should be avoided also in participants with no evidence of thyroid disease.

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Competing interests None.

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