Selenium toxicity: A rare diagnosis

Sir,

While trace elements are essential for normal body growth and regulation, excess intake of these elements can lead to toxic effects. Selenium is an essential trace element which is a constituent of more than two dozen selenoproteins that play a critical role in reproduction, thyroid hormone metabolism, deoxyribonucleic acid synthesis and protection from oxidative damage and infection. However, it is known to be toxic with a narrow interval separating deficiency and toxicity. According to the World Health Organization, selenium toxicity is prevalent in South Dakota (USA), Venezuela, and China. In India, selenium toxicity has been reported in Hoshiarpur and Nawansahar districts of Punjab.

A 35-year-old man presented at SMS Medical College and Hospital, Jaipur with a four-month history of dystrophy of all nails and a one-month history of hair loss and fragility of hair all over the body. Initially, white spots and longitudinal red streaks appeared on the nail surface followed by increased brittleness and breaks in the nail plate. The new nails that grew subsequently were also dystrophic. The thumb nail was the first to be affected and later all twenty nails were involved. In some of the fingernails, fluid effused from the nail folds and there was pain at the fingertips. Within 2-3 months he noticed increased hair fragility and loss of scalp, beard, axillary, pubic and body hair. There was no significant history of any drug intake or chronic systemic disease. There were similar complaints in eleven members of his family and four members of a neighboring family. On examination, there was involvement of all the finger and toe nails with varying severity in these individuals. There was patchy erythronychia with transverse, subtotal or distal leukonychia, onycholysis and roughening of the nail plate. Hair on the scalp, eyebrows, beard and mustache were dry, brittle and broke easily on slight pulling. Hair density was also decreased on the entire scalp, most pronounced on the occipital area. There was no mucosal involvement. General physical and systemic examinations were also unremarkable. Potassium hydroxide preparation and fungal culture of nail clippings were negative. Hair microscopy showed pigmented, shrunken anagen hair bulbs. Hair shafts were normal with no beading, twisting, nodes or fractures. Nail biopsy showed hyperkeratosis and irregular acanthosis with intra-corneal neutrophilic abscess. An intra-epidermal cleft was seen, filled with red blood cells and acute and chronic inflammatory cells. The dermis showed dense perivascular infiltration by acute and chronic inflammatory cells. All routine blood investigations were within normal limits.

On further evaluation, no abnormality was detected on electrocardiography, however, nerve conduction studies revealed signs of peripheral motor neuropathy affecting both the common peroneal nerves. Magnetic resonance angiography of the hand (to rule out microvascular involvement) was normal and computed tomography scan of the hand showed osteochondritis of the carpal bone.

Abrupt onset of hair loss and nail dystrophy and the presence of symptoms in the whole family along with a neighboring family made us suspect chronic poisoning due to some organic or inorganic material. Samples were taken from the hair and nails of the most severely affected patient and were sent to a laboratory for analysis.
Inductively coupled plasma mass spectrometry revealed an excessive amount of selenium in the samples. The concentrations of selenium detected in the nail and hair were 27 µg/g and 35 µg/g respectively. The corresponding normal values are 0.809 µg/g and 0.36 µg/g, respectively for nail and hair.\(^{[3,4]}\) Thus, the amount of selenium detected was almost 30 times higher in nails and almost 100 times higher in hair. Since the signs of poisoning were limited to only two families in the area, the potential sources were either polluted water supply or food material. It was found that both families were using wheat grain from the same source. Thus, the suspected wheat grain sample along with a control wheat grain sample (with no symptoms on consumption) were sent to the laboratory for analysis. Furthermore, a water sample was sent for analysis. The selenium concentration in the control wheat grain sample was 0.43 mg/kg, whereas it was 152.82 mg/kg in the suspected wheat grain sample. The reported normal value for selenium in wheat grains is 0.61 ± 0.006 mg/kg.\(^{[4]}\) Thus, the level detected in the suspected wheat grains was almost 250 times higher than normal. Selenium was not detectable in the water sample.

The patients recovered remarkably, with growth of healthy nails and hair, after they stopped consumption of the toxic wheat.

Selenium is an essential element and its recommended daily allowance varies from 55 to 70 µg/day. The major source is dietary; it is present mostly bound to animal and plant proteins. The food sources are meats and seafood (0.3–0.5 mg/kg), cereals (0.1–10 mg/kg), vegetables and fruits (<0.01 mg/kg). The selenium content in crops depends on the water soluble

### Table 1: Clinical findings of all individuals

| Age (in years) | Sex  | Duration of symptoms (months) | Hair involvement | Nail involvement | Skin involvement |
|----------------|------|-------------------------------|------------------|------------------|------------------|
| 65             | Male | 3                             | Present          | Present          | Absent           |
| 60             | Female | 1                             | Present          | Present          | Absent           |
| 35             | Male | 4                             | Present          | Present          | Absent           |
| 32             | Male | 6                             | Absent           | Present          | Absent           |
| 30             | Male | 4                             | Present          | Present          | Absent           |
| 28             | Female | 2                             | Present          | Present          | Absent           |
| 27             | Female | 1                             | Present          | Present          | Absent           |
| 25             | Female | 2                             | Absent           | Present          | Absent           |
| 9              | Female | 2                             | Absent           | Present          | Absent           |
| 7              | Male | 2.5                           | Present          | Present          | Absent           |
| 60             | Male | 1                             | Present          | Present          | Absent           |
| 27             | Male | 3                             | Present          | Present          | Absent           |
| 23             | Male | 5                             | Present          | Present          | Absent           |
| 18             | Female | 2                             | Present          | Present          | Absent           |

Figure 2: Dystrophy of toenails

Figure 3: Patchy loss of hair over scalp
selenium present in soil and the amount in animals depends on their feed. Water per se, due to its low selenium content, is an unlikely source of selenium toxicity except in areas with an excess of selenium in the soil. The level of selenium in most urban air ranges from 0.1 to 10 ng/m³, but higher levels may be found in certain areas such as near copper smelters. 

Most water-soluble inorganic and organic selenium compounds present in food are absorbed across the gastrointestinal tract (80–95%). After absorption, selenium is cleared by the liver and then transported by a specific transporter, selenoprotein P, to all organs with the highest concentrations occurring in the kidney, liver, spleen, testes and skeletal muscle. The mechanisms of selenium toxicity at the cellular or molecular level are not yet fully understood. However, it is believed that it can interact with glutathione to form reactive selenotrisulfides and generate toxic superoxide and hydrogen peroxide species, oxidizing cell membranes and macromolecules, thereby damaging cell integrity and resulting in necrosis or apoptosis. In a study in which human cells were treated with selenium, it was observed that selenium at higher levels has a cytotoxic effect with depletion of lipids and proteins and DNA damage. Stewart et al. reported significant DNA-adduct formation in mouse keratinocytes (BALB/c MK-2) treated with 5 mg/L Se as a consequence of oxidation which is thought to directly arise from the generation of the hydroxyl (–OH) radicals.

Very low selenium status in humans has been associated with a juvenile, multifocal myocardiitis called Keshan disease and a chondrodystrophy called Kaschin–Beck disease. Chronic selenium toxicity leads to loss of hair and nails. Hair breaks at the level of the scalp with slight trauma, such as scratching, while the follicles remain intact. Hair can be lost from any body site. A rash on the scalp with severe itching has also been reported. Nails become brittle and are shed and the new nail is also dystrophic. Skin lesions have been reported, mainly on the limbs, i.e., dorsum of hands and feet, the outer side of legs and thighs, the forearms and the back of the neck. Affected skin becomes red and swollen and then blistered and ulcerated. Reddish pigmentation of the skin usually remains and gooseflesh may be left on the neck and thighs. Dental anomalies such as tooth decay and molting might also be seen. Abnormalities of the nervous system such as peripheral anesthesia, “pins and needles,” acroparesthesia, pain in the extremities, hyperreflexia of the tendons and motor disturbances are other features. Decreases in prothrombin time and in the concentration of glutathione have also been reported. The only effective treatment is discontinuation of the source of selenium, i.e., either contaminated food material or water.

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Conflicts of interest
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Anonychia with absent phalanges and brachydactyly: A report of two unrelated cases

Sir,

Congenital anonychia or its milder phenotypic counterpart, hyponychia, is a relatively rare abnormality of nail development affecting all or some of the finger and toe nails, characterized by the complete absence of nails or the presence of only rudimentary nails, respectively. It could occur as an isolated abnormality, termed anonychia simplex or as part of a syndrome.

We report two cases of partial hyponychia/anonychia with underlying absent distal phalanges in both, and in addition hypoplastic/absent middle phalanges in one of them.

A 35‑day‑old female child, second born to non‑consanguineous parents was brought with absent finger nails since birth. The mother denied any intake of medication or illness during the antepartum period. There was no similar history in the family. The child had short digits along with rudimentary nails of digits 2, 3, and 5 of the right hand and digit 5 of the right hand with absence of nails on digit 4 of the right hand and digits 3 and 4 of the left hand; the nails of the index finger of left hand, both thumbs and all toes were normal [Figure 1a and b].

The head circumference was 35 cm (50th centile for age) and there was no facial dysmorphism. The skin did not reveal any pigmentary abnormality. The plain radiograph of both the hands revealed the absence of distal phalanges of digits 2‑5 [Figure 1c and d]. The child's pelvis X‑ray did not show iliac horns, the renal function was normal and the ultrasound of abdomen did not show any renal abnormality. The child's brainstem‑evoked response audiometry (BERA) was also normal.

Our second case was a 11‑year‑old girl, second born of a non‑consanguineous marriage, with congenital absence of nails of the right hand. There was neither a positive family history nor a history of maternal drug intake during pregnancy. Her right hand had shortened digits 2‑4 with poorly defined finger creases. Digits 3 and 4 had anonychia, whereas the little finger and index finger nails were hypoplastic [Figure 2a and b]. The nails of the right thumb, all digits of the left hand and all toes were normal. X‑ray showed absence of middle and distal phalanges of digits 3‑5 and absence of distal phalanx with hypoplasia and tapering of the middle phalanx [Figure 2c]. She had no other cutaneous abnormalities.

Congenital anonychia/hyponychia is a spectrum of nail abnormalities which often occur concurrently in an individual. It is inherited as an autosomal dominant or recessive trait or can occur sporadically.

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