Introduction

Suicide is an important public health issue worldwide, and pesticide self-poisoning is one of the main methods used to commit suicide. South Korea’s suicide rate in 2018 was 25.5 per 100,000 people, which was more than twice as high as the average rate (11.5 per 100,000) of the Organisation for Economic Co-operation and Development (OECD), ranking first among OECD countries [1]. In 2018, drug poisoning (56.3%) was the top suicide method in South Korea, followed by sharp objects such as knives (15.0%), gas (10.3%), and pesticide poisoning (8.8%) [2].

Paraquat, a herbicide, was identified as the most frequently used pesticide for self-poisoning and had the highest fatality rate [3]. The most common route of administration for self-poisoning with pesticides is oral ingestion, although a few cases of intravenous, intramuscular, and subcutaneous administration have been reported [4]. No cases of pesticide self-poisoning through intramuscular injection in South Korea have been published, nor any cases of self-poisoning with cyantraniliprole. Herein, we report the case of a patient who intramuscularly injected cyantraniliprole into the rectus abdominis muscle with the intent to commit suicide, but recovered fully without any systemic complications. The patient provided written informed consent for the publication and the use of his images.

Case

An 80-year-old male visited the emergency room with a chief complaint of right ab-
Intramuscular injection of pesticide

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Abdominal pain. A day before presenting to the hospital, the patient self-injected 3 mL of cyantraniliprole (commercial name: Exirel) into the right abdomen to commit suicide after a conflict with a neighbor. The patient had hypertension, diabetes, and hyperlipidemia, but no other pre-existing diseases or history of psychiatric evaluation.

Initial examination revealed no noticeable symptoms other than cellulitis in the injection area with localized redness, swelling and pain (Fig. 1). On computed tomography (CT) taken in the emergency room, diffuse fluid collection and edematous swelling were observed from the right rectus abdominis muscle to the subcutaneous fatty layer (Fig. 2A). No fluctuating lesions were palpable during the physical examination due to severe swelling and hardness. A blood panel including a complete blood count, coagulation panel, electrolytes, liver function test, and muscle enzymes was conducted. The white blood cell count and C-reactive protein levels were elevated (20,000/μL and 13 mg/dL, respectively), and the other tests were all normal.

To manage the cellulitis, it was decided to use cefazolin, a first-generation cephalosporin antibiotic, and observe the patient’s clinical course. The decision for temporary conservative management was based on the low toxicity of cyantraniliprole in mammals. After the swelling and hardness improved and loculated fluid collections were observed on follow-up CT images, surgical incision and drainage was to be performed.

Ten days after the self-poisoning and with 1 week of antibiotic administration, the white blood cell count and C-reactive protein levels returned to normal ranges. As the local swelling, redness, and hardness had also improved, antibiotics were stopped. Localized fluctuations, which had become palpable on abdominal physical examination, were observed on follow-up enhanced abdominal CT (Fig. 2B). Abdominal incision and drainage was performed to drain serous exudate fluid collection, and deposits of solid white powder presumed to be pesticide residue were visible in the subcutaneous fatty tissue. Povidone-soaked gauze packing dressings were changed three times daily for 3 weeks (Fig. 3).

On follow-up enhanced abdominal CT taken 1 month after pesticide injection, the fluid collection and edematous swelling had reduced significantly compared to previous CT examinations (Fig. 2C). En bloc excision including unhealthy granulation tissue was performed, and after confirming the absence of any remaining white powder, the excision site was closed by delayed primary closure (Fig. 4). The specimen removed en...
bloc was sent to the pathology department for biopsy, and the results indicated a foreign body reaction accompanied by fat necrosis and inflammation. The surgical site healed well without any local inflammation, and no systemic side effects such as dyspnea and general weakness were observed during the hospitalization and follow-up period (Fig. 5).

Discussion

Cyantraniliprole is a synthetic insecticide with a molecular structure of C₁₉H₁₄BrClN₆O₂ that appears as a solid white powder. As a new second-generation ryanodine receptor insecticide, its mechanism involves the unregulated activation of the ryanodine receptor channel in insects. This causes internal calcium store depletion, disorganized muscle contraction, and paralysis in insects, enabling it to function as an insecticide [5]. Cyantraniliprole is a wide-range insecticide that is effective against chewing pests such as whiteflies, thrips, and aphids, and also sucking pests. It is not volatile and has low water solubility; thus, it remains in very small amounts in the soil or water. It is used for a wide range of crops, including onions, potatoes, tomatoes, and pumpkins [6].

Unlike paraquat, which can cause acute kidney and liver injury requiring the use of hemodialysis and hepatotonic, and respiratory failure due to pulmonary fibrosis with a very high mortality rate [7], cyantraniliprole is known to have low toxicity in mammals with low bioaccumulation potential [6]. However, da Silva Scarton et al. [8] recently discovered that cyantraniliprole exhibits reproductive toxicity in mammals. According to their study, although reactive oxygen species and antioxidant systems are balanced in a healthy organism, intracellular Ca²⁺ depletion due to cyantraniliprole increases the reactive oxygen species level and induces oxidative stress, there-
by negatively affecting the reproductive system [8]. Since intracellular Ca\(^{2+}\) signaling also plays an important role in muscle contraction and neurotransmitter release [9], it is thought that cyantraniliprole may cause paralysis or hormone dysfunction in mammals. However, this possibility has not been conclusively demonstrated.

There are few studies on its toxicity to humans, but it has been shown to be unrelated to cancer and reproductive or developmental disorders. Its effects on the ocular and skin surfaces and respiratory, neural, endocrine, and metabolic systems of the human body are not known [6].

When chlorinated hydrocarbon pesticides are injected intravenously, they can cause tissue damage in the form of necrotizing fasciitis, which progresses by dissolving the lipid-rich membranes of the microvasculature in the human body [10]. In contrast, it is not known in detail what kind of tissue damage anthranilic diamide pesticides (including cyantraniliprole) cause when injected intravenously or intramuscularly in the human body. In this case study, local tenderness and redness occurred after intramuscular injection, but the symptoms did not progress as in necrotizing fasciitis and noticeably improved with time. Although pathological examination displayed foreign body reaction accompanied by fat necrosis and inflammation, the mechanism through which cyantraniliprole exerted this effect is unknown. The injected cyantraniliprole only caused local problems at the intramuscular injection site and did not cause any systemic reactions.

The relatively short follow-up period in this case study somewhat limited the observation of complications or systemic reactions. Blood panels including a complete blood count, coagulation panel, electrolytes, liver function and muscle enzyme tests were conducted regularly for 6 months with chest X-rays. These tests all showed normal results, and the patient reported no abnormal bodily symptoms.

Cyantraniliprole-related pesticide self-poisoning and human health issues have not been studied in depth [6]. This is also the first reported case of cyantraniliprole intramuscular injection, rather than oral intake. A literature search of the Ovid, PubMed, Scopus, and Web of Science electronic databases on August 30, 2022, using the terms “cyantraniliprole,” “injection,” and “suicide” and without date or language restriction, revealed no other reports.

Although more studies are necessary to elucidate the toxic action of cyantraniliprole in humans, clinicians who encounter similar cases are recommended to perform surgery after adequate control of local inflammation if a patient does not display systemic toxicity signs, like the patient described in this case report. However, there might be unrevealed toxicity in mammals, as suggested by da Silva Scarton et al. [8]. Therefore, it is recommended to perform a surgical procedure that cleanly removes the residual foreign bodies in an en bloc manner as soon as possible.

### Conflict of interest

Jae Ha Hwang is an editorial board member of the journal but was not involved in the peer reviewer selection, evaluation, or decision process of this article. No other potential conflicts of interest relevant to this article were reported.

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