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Body Imaging

Imaging of eggshells and eggs in the gastrointestinal tract: pictorial essay

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ABSTRACT

Ingestion of eggshell in its natural form or as ground and powdered product has become a popular means of dietary calcium supplementation in adults. These substances appear as conspicuous radiopaque material within the gastrointestinal tract on radiographs or computed tomography of the abdomen. The ingested eggshell fragments are usually visible as curvilinear structures on profile view, whereas the ground or powdered eggshells appear as granular densities.

This article illustrates the spectrum of findings that are observed following eggshell ingestion by patients undergoing radiological evaluation for various unrelated medical conditions. Potential complications of eggshell consumption are discussed, and two cases of intra-rectal egg insertion for palliative relief of pelvic pain are presented.

1. Introduction

Chicken eggs have been used as a food source by human beings since the prehistoric times. About 1,652 billion eggs were produced worldwide in 2019, and the leading countries were China, India, and the United States. It has been estimated that about 110 billion tons of eggshells have been generated globally, most of it disposed as solid waste and deposited in municipal landfills.^{1–4}

During the past several decades, there has been a growing awareness regarding the nutritional value of eggshells as a dietary supplement for calcium and its usage for various medical and industrial applications.^{5–9}

Over 95% of eggshell is composed of calcium carbonate, containing about 380 mg of calcium per gram. Therefore, half of an eggshell would provide the daily need of calcium by an average adult.^{4,5,9}

The commercially available eggshell supplements are in powdered form, which can be ingested directly or mixed with other foods. However, some individuals prefer to chew and eat the natural shells of hard-boiled chicken eggs as a cheap alternative. In such cases the radiopaque pieces of eggshells can be visible on their radiographs or CT of the abdomen.

The purpose of this essay is to illustrate the imaging features of eggshells within the gastrointestinal tract. The radiographic appearance of eggs that are occasionally inserted into the rectum for palliative treatment of pelvic pain is also presented, and the pertinent literature about the potential complications of eggshell consumption is reviewed.

2. Radiographic appearance of eggshells

To better visualize as how the eggshells would appear on abdominal radiographs, several pieces were immersed in a water-filled Petri dish and radiographed at 100KVp (Fig. 1). Because the eggshell has a thickness of about 0.3–0.4 mm, its fragments are best seen in profile as small curvilinear opacity. Their enface view produces a rather faint image of an irregularly shaped item. When 2 or more pieces are clumped together, however, they appear as a much denser radiopaque object.

3. Eggshells in the stomach

An abdominal radiograph obtained following ingestion of powdered eggshell products will demonstrate a milky appearance of the gastric content (Fig. 2A). CT examination of patients who ingest the eggshell in ground form will reveal more distinct granular densities (Fig. 2B).

CT examination of patients who eat the actual eggshell pieces will clearly show them due to the high sensitivity of this modality for detection of calcium containing structures. The typical appearance of eggshells on cross-section is that of small linear or curved radiopaque objects (Fig. 3A). A cluster of denser fragments can be seen if the patient undergoes CT evaluation shortly after eating large number of eggshells (Fig. 3B).

It should be noted that the hydrochloric acid in the stomach will interact with calcium carbonate in eggshells and releases carbon

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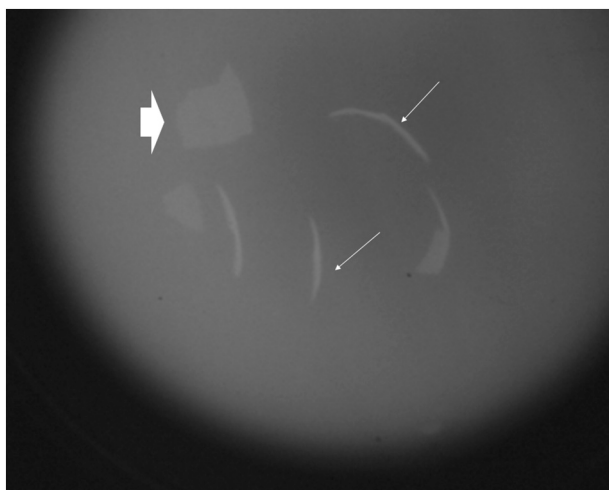


Fig. 1. Radiographic appearance of several eggshell pieces immersed in a water-filled Petri dish. Eggshells seen in profile are radiopaque and curvilinear (small arrows), but they are faintly visible on enface projection (large arrow).

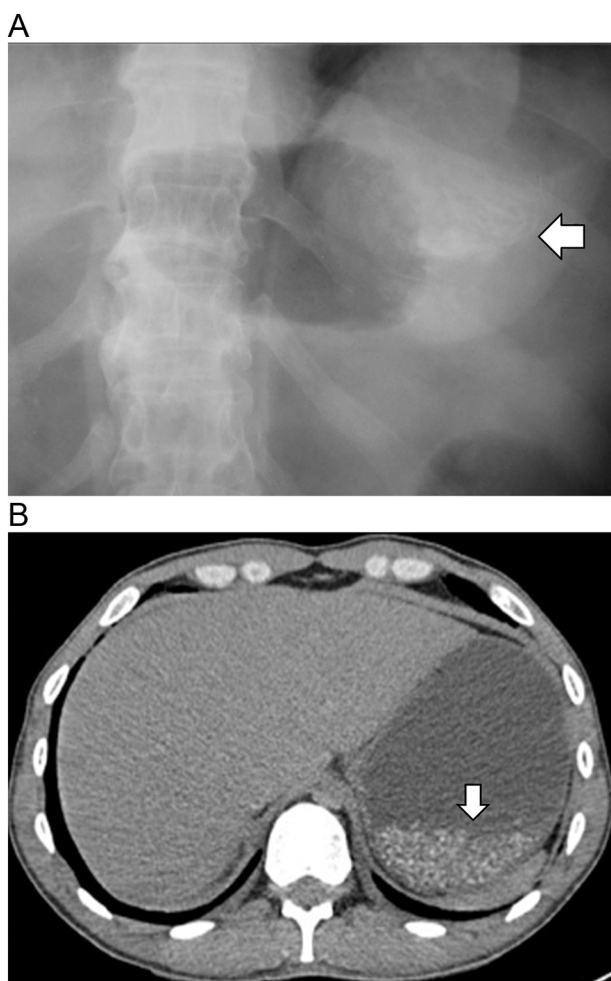


Fig. 2. Images of ingested eggshell powder in 2 patients. A. Radiograph of the left upper abdomen shows a milky appearance of the gastric content in a man who had ingested a teaspoon of pulverized eggshell (arrow). B. CT image demonstrates a cluster of granular densities in the gastric fundus (arrow).

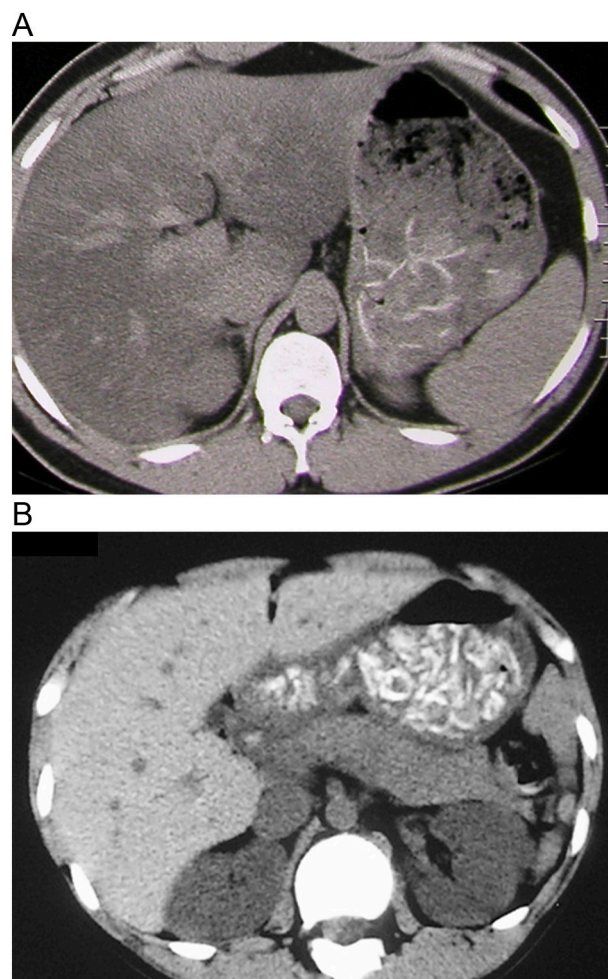


Fig. 3. CT appearance of ingested eggshells in 2 patients. A. Multiple curvilinear eggshell fragments are visible in the stomach of this 24-year-old man during CT urography. B. A large collection of radiopaque eggshells is seen in this 10-year-old girl with Wilson's disease and mental disability. Her parents claimed that she had eaten 2 boiled eggs with shells prior to this examination.

dioxide.¹⁰ This chemical process will gradually decrease their conspicuity on radiological studies. However, most eggshell fragments will pass through the gastrointestinal tract in an intact shape.

4. Eggshells in the small bowel

Abdominal radiographs of patients who ingest the crushed eggshells as a suspension in milk or fruit juice will disclose scattered radiopaque foci within their intestine (Fig. 4A). These patients are often willing to provide information to clarify the nature of unusual densities seen in their bowel loops.

Sometimes a few pieces of eggshell are trapped within the small bowel or a Meckel's diverticulum, will become encrusted over a prolonged time, and serve as a nidus for the formation of enteroliths (Fig. 4B).

5. Eggshells in the colon

Most of the ingested eggshells can pass into the colon in their intact shape and will be recognized as multiple curvilinear radiopaque foreign bodies (Fig. 5A and B). Both illustrated cases involved elderly patients with femoral fractures, who had been advised by their friends to ingest eggshells for treatment of osteoporosis and to facilitate bone healing. This information was revealed on further inquiry from the patients

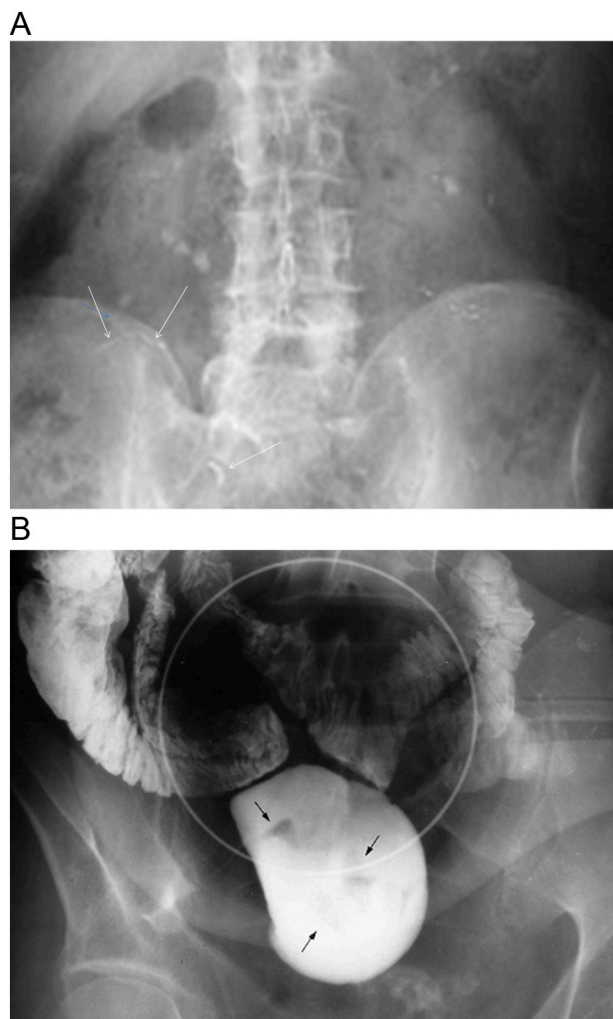


Fig. 4. Radiographic features of eggshells in the small bowel of 2 patients. A. Abdominal radiograph shows scattered radiopacities due to clumped eggshells in the bowel loops, some with a linear or curved configuration (arrows). B. Radiograph of a barium-filled Meckel's diverticulum reveals several irregularly shaped objects within its lumen (arrows). The resected specimen disclosed that these were encrusted eggshell pieces.



Fig. 5. Radiograph of the abdomen shows granular content of the colon in this man, who had been using eggshell powder as calcium supplement (arrows).

because these curved foreign bodies had been initially diagnosed as swallowed nail clippings. However, nails are not radiopaque and cannot be visualized on radiographs of the hands or feet.

Most patients tend to consume the commercially available eggshell powder as a calcium supplement. This product will then cause a fine granular appearance of the colonic content on abdominal radiograph (Fig. 6).

6. Eggs in the rectum

There has been isolated observation of patients in whom an intact hard-boiled egg was intentionally inserted into the rectum for palliative treatment of pain in the pelvic region, as it was done in this young Iranian girl with a non-union of right femoral neck fracture (Fig. 7A). This unusual therapeutic approach is based on a mythical belief by some people of the Middle Eastern ethnicity that an intrarectal egg would exert pressure on the pelvic nerves and ameliorate pain in that area.

Because an egg can break easily during the attempted insertion or while it is within the rectum, an egg-shaped marble is sometimes used for the same purpose (Fig. 7B). In a case reported by Kasotakis and colleagues, a 41-year-old man had inserted a marble egg into his rectum

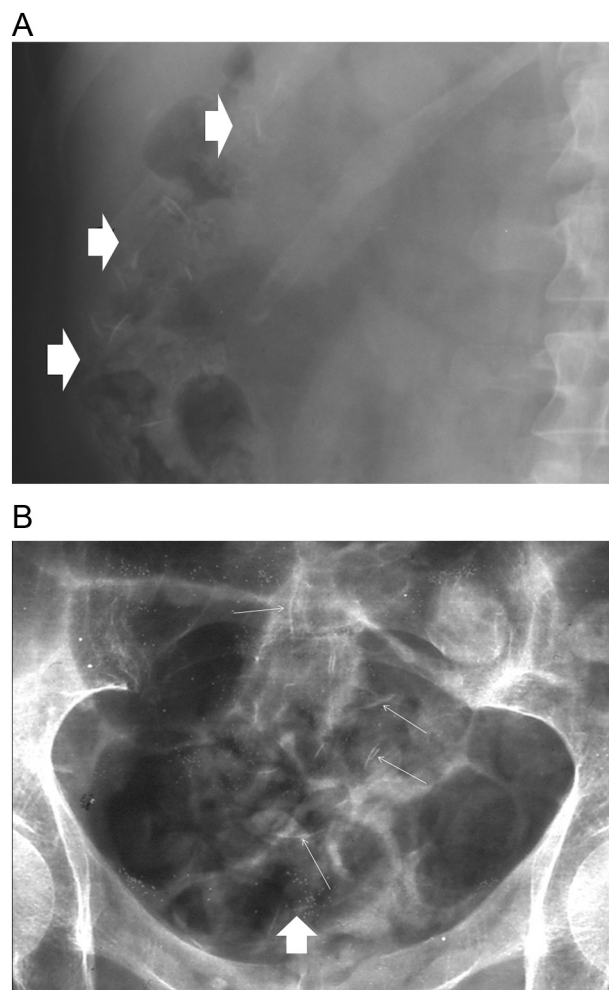


Fig. 6. Radiographic appearance of eggshells in the colon of 2 patients. A. Close-up image of the right upper abdomen demonstrates multiple curvilinear foreign bodies in the ascending colon (arrows). This 52-year-old man had been eating eggshells to facilitate healing of his femoral fracture. B. Radiograph of the pelvis shows several radiopaque eggshell fragments in the colorectal region (small arrows). Punctate densities within the right hemicolon (large arrow) are caused by ground eggshells that this 72-year-old woman was also taking for the treatment of osteoporosis.

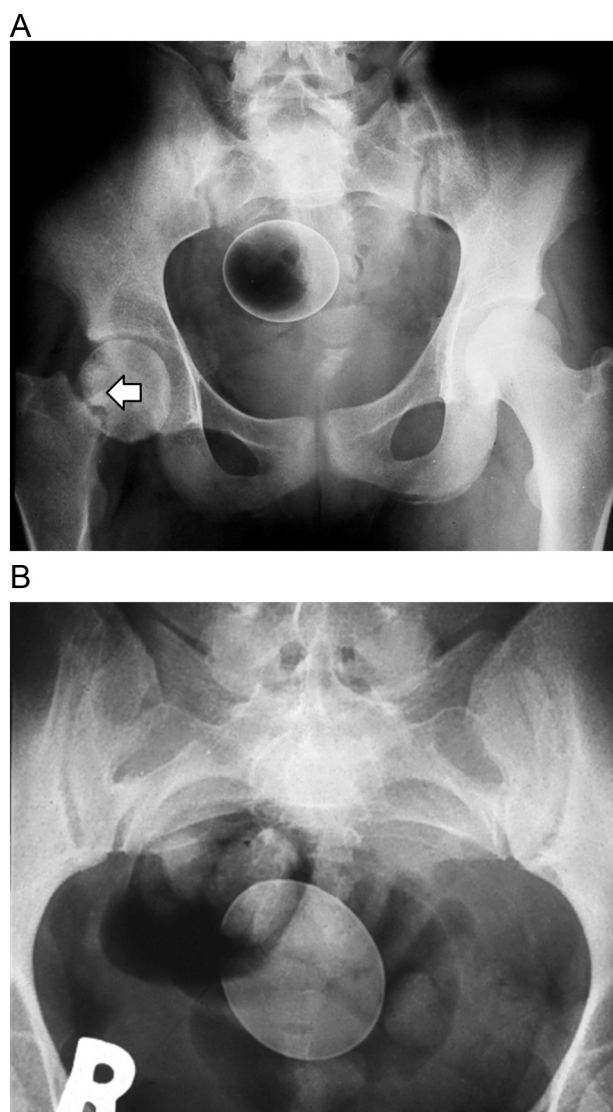


Fig. 7. Radiographic features of eggs in the rectum. A. This image reveals the typical appearance of a hard-boiled egg that had been inserted into the rectum of a 14-year-old Iranian girl for the relief of pain caused by non-union of her right femoral neck fracture (arrow). B. This radiograph shows an egg-shaped marble in the rectum of a 54-year-old woman. It had been inserted for palliative treatment of her pelvic pain. (Courtesy of Dr. Saeed Rad, Tabriz University of Medical Sciences, Tabriz, Iran).

for sexual gratification, and he required surgical intervention for its removal.¹¹

7. Discussion

Eggshell is a bio-ceramic structure of about 0.3–0.4 mm in thickness, composed of over 95% calcium carbonate and minimal amount of other minerals and organic material.^{1,12,13} The latter serves as a protein matrix for the calcium crystals and accounts for the hardening of otherwise brittle eggshell. The inner wall of the egg is covered by 2 thin fibrous membranes, which have proven to have significant therapeutic effect for various disorders, most notably osteoarthritis and inflammatory bowel diseases.^{14–16}

It has been documented that the eggshells provide a cheap alternative source for dietary calcium intake.^{2–6} Therefore, the natural eggshells and their commercial products are widely used as a calcium supplement throughout the world.^{1,8,9} In the United States, about 70%

of adults over the age of 65 years and a third of children and adolescents are using supplements of vitamins and minerals on daily basis, including many who ingest eggshells in various forms.¹⁷

There are ample references in the radiological literature about the eggshell calcifications occurring in the periphery of lymph nodes in silicosis, coal-miners pneumoconiosis, and other conditions.^{18,19} However, the imaging features of eggshell ingestion have not been published previously. A search of Medline revealed only few articles related to this subject. Ihoriya and Ichiba recently reported a 76-year-old, who had small bowel perforation due to ingested eggshells.²⁰ There have been 3 case reports of eggshell aspiration in children.^{21,22} Another noted complication has been development of salmonella enteritis caused by contaminated eggshells.^{9,23}

It may be of interest to mention that some investigators had employed imaging techniques to evaluate the thickness and structure of eggshells. Riley et al. had used micro-computed tomography for quantification of eggshell structure.²⁴ Kiba et al. had measured the eggshell thickness by ultrasound.²⁵ Nevertheless, no prior clinical studies concerning the eggshells in human body had been performed.

It is hoped that this pictorial essay would enhance the knowledge of practicing radiologists about the manifestations of ingested eggshells in patients who undergo radiography or CT of the abdomen for unrelated medical conditions. Awareness about these findings would facilitate correct identification of such radiopaque substances during the imaging studies.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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