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Comparison of Contrast-Induced Gastrography with Iohexol, Iodixanol and Barium Sulfate in Common Mynah Bird (*Acroidotheres tristis*)

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ABSTRACT

This study was conducted to evaluate the effect of the comparative study of contrast media for gastrography of the mynah bird. This study was conducted on 12 adult male mynah birds. Using different contrast agents, all the birds were studied five times, with a minimum of two days of the time interval between each study. Radiographic tests were performed 1, 5, 15, 30, 60, and 90 minutes after ingesting the contrast agent via using a gavage tract; imaging was performed at a time interval of 30 minutes and continued until the time when the contrast agent reached the cloaca and was excreted. There was a statistically significant difference between the results of digestive system studies using Iodixanol, Iohexol, and barium sulfate in terms of mean scores of the contrast agent's ability to fill different parts of the gastrointestinal tract, clarity of observations, and observing details of the gastrointestinal tract at all times of radiography ($p < 0.05$). Iodixanol is less nephrotoxic and is a better contrast agent, however, we do not recommend using Iodixanol and Iohexol diluted by water at a ratio of 1:1.

Introduction

Radiographic contrast media administered via an orogastric tube are often used to aid in the diagnosis of intestinal obstruction and foreign bodies. Barium sulfate, Iohexol and Iodixanol has been used as a gastrointestinal contrast medium in chelonians. When conventional radiography is not effective enough to show certain parts of the body especially in the abdominal area, certain techniques are used to reflect the suspected harm or members in the radiographic image. These techniques are progressing day by day; in addition, some efforts have been made to utilize radiology in the diagnosis of diseases in animals. Contrast agent is often used to study the suspected cases of bulky mass, wound, disorders in size and shape, external objects in digestive tract, changes in motion, and disorders of the circulatory system walls.[1,2] Gastrointestinal contrast study is a common non-invasive diagnostic technique that does not require anesthesia and enables good visualization of the digestive tract.[3,4] Iodine-based contrast agents such as diatrizoate sodium and diatrizoate meglumine are recommended to be used for patients with suspected

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gastrointestinal perforations.[5] Iohexol (5-[N-(2,3-dihydroxypropyl) acetamido]-2,4,6-triiodo-N, N'-bis(2,3-dihydroxypropyl) isophthalamide) is a non-radioactive, low-osmolar, iodinated, water-soluble radiographic contrast medium. Iohexol has also played a fundamental role in assessing intestinal permeability (IP), having been successfully used as an IP marker in humans, dogs, horses and rats.[6] Hypertonic materials can dehydrate the body. In addition, as the water in the gastrointestinal tract is absorbed by the hyperosmolarity of the environment, the resolution of the digestive tract is reduced due to dilution. Iodixanol and Iohexol is a non-ionic iodinated contrast agent with a low osmolarity which is used as a contrast medium and can be used instead of barium sulfate for studying birds suspected of gastrointestinal tract perforation.[6-8] Mynahs are birds of the starling family (Sturnidae), the word mynah being a local name for starlings from India and surrounding countries. In the west, we are most familiar with mynahs as entertaining cage birds, with an ability to vocalise human words. In the wild there are in the order of thirty species of mynah, some, but not all of which, are good vocal mimics. They are closely related to that other group of avian impressionists, the Mimids (mockingbirds and thrashers) of North America. The native homes of starlings and mynahs are scattered across Eurasia, Africa and Australasia. Mynahs' closest relations in Europe are our Common Starlings (Sturnus vulgaris). Some mynah species are now considered invasive in countries outside their natural range (e.g. North America, Australia and New Zealand, and some Pacific Islands). Mynahs form the bulk of the genera Acridotheres, Ampeliceps, Basilornis, Enodes, Gracula, Gracupica, Leucopsar, Mino, Scissirostrum and Streptocitta and many other starling genera are often referred to as mynahs. Most mynahs are black or dark with the exception of the critically endangered Bali Mynah (Leucopsar rothschildi) which is largely white. Mynah is a symbol of long-lasting love.[9]

Materials and Methods

All methods used in this study were proved by the Animal Care Institute and Animal Protection Committee of Islamic Azad University. This study was conducted on 12 adult male mynah birds, each weighing 120-160 g. Based on physical examinations, plasma biochemical factor tests, and complete blood cell count (CBCs), all the birds were healthy. Prior to testing, stool exam was also performed and the results showed that all the birds were healthy. After the tests, the same dietary regimen was used for all the birds and they were housed at the same conditions. Moreover, the birds underwent NPO regimen (Nil per os is a medical instruction meaning to withhold foo11d and fluids) 24 hours before the test.[10] In order to prevent any change in gastrointestinal motility, we did not used anesthesia or sedation for birds. All the radiographic examinations were performed using a radiographic unit (ECOVET-DX/HF-525PLUS FPD EcoRay, Seoul, Korea) and digital flat-panel detector (Flat panel Vivix-S 2532T, Seriate (BG) Italy), utilizing 44 kVp and 4–5 mAs settings. Using different contrast agents, all the birds were studied five times, with a minimum of two days of time interval between each study. In the first study, non-diluted Iohexol (Omnipaque 240 mgI/ml) at two different concentrations,[11] and in the second study it was diluted by water at a ratio of 1 to 1 and then was used.[12-14] In the third study, we used non-diluted Iodixanol (Visipaque 320 mgI/ml) at two different concentrations, and in the fourth study it was diluted by water at a ratio of 1 to 1 and then was used. In the fifth study we used barium sulfate at a concentration of 60%. The dosage of contrast agent was determined based on the size of the crop and it remained constant throughout the study; accordingly, a dosage of 20 to 25 ml per kg was used for each bird. Radiographic tests were performed 0, 5, 15, 30, 60, and 90 minutes after ingesting the contrast agent via using a gavage tract; imaging was performed at a time interval of 30 minutes and continued until the time when the contrast agent reached cloaca and was excreted. The quality standards of the film were the followings: contrast agent's ability to fill and clearly show gastrointestinal tract, visibility of the structure, shape, size, location, and mucosal details of the gastrointestinal system. Based on these criteria, the films were identified as good, moderate, and non-acceptable and the optimal times to assess different parts of the digestive tract were determined.[15,16] Finally, using SPSS statistical software, the mean, range, and standard error of each of the variables were calculated; moreover, Kruskal-Wallis test was used to compare the means. The data were analysed by one-way analysis of variance and scheffe post hoc test, using SPSS statistical software.

Results

At the 0 minute, the contrast agent was observed in the crops of groups of birds taking Iodixanol and Iohexol and barium sulfate (Figure 1); in one case, we observed a sign of the entrance of the contrast agent

into the proventriculus, and ventriculus with a low opacity. At the 5th minute, barium sulfate contrast agent was observed in the crop, proventriculus, part, and gizzard, however, its opacity was low in proventriculus, and ventriculus (Figure 1a). In the birds receiving Iodixanol and Iohexol, the contrast agent was observed not only in crop, proventriculus, part, and gizzard, but also it was seen at duodenum with a low opacity. At the 15th minute, Iodixanol and Iohexol contrast agent was observed in the duodenum with a higher opacity and there was no sign of the entrance of the contrast agent into the smaller parts of the intestine. At the 30th minute, the first sign of the arrival of contrast agent to the small intestine was observed in two cases (Figure 1b). At the 60th minute, barium sulfate contrast agent was observed in all parts of the gastrointestinal system, except for cloaca; however, Iohexol contrast agent was observed in cloaca as well (Figure 1c). At the 90th minute, barium sulfate contrast agent was increased in the small intestine and then in the large intestine (Figure 1d). At the 120th minute the amount of the contrast agent in the initial parts of crop, proventriculus, and ventriculus was reduced and it had not a clear opacity. Finally, at the 150th minuteafter administration of barium sulfate, it was observed in the cloaca (Figure 1e). At the 60th minute, the amount of Iodixanol and Iohexol contrast agent was increased in the small intestine and then in the large intestine; at the 90th minute, the amount of the contrast agent in the initial parts of crop, proventriculus, and ventriculus was reduced and it had not a clear opacity, however it was observed in the small intestine and cloaca. At the 150th and 60th minute of the administration of barium sulfate and Iodixanol and Iohexol, respectively, we observed the first signs of the presence of contrast agent in the stool.

Statistical analysis: The data were analysed by one-way analysis of variance and scheffe post hoc test, using SPSS statistical software. There were statistically significant differences between the administration of Iodixanol and Iohexol and barium sulfate in terms of the mean scores of the ability of the contrast agent to fill different parts of the gastrointestinal tract, the clarity of the observations, and the visibility of the details of gastrointestinal tract at all times of radiography ($p \leq 0.05$). However, no statistically significant difference was observed between three contrast agents in terms of the mean scores attributed to gizzard but at the 60th minute a significant correlation of the administration of barium sulfate and Iodixanol and Iohexol was found and at the 90th minute until 180th minute a significant correlation of the administration of barium sulfate and Iodixanol and Iohexol was found and at the 150th minute until 180th minute a significant correlation of the administration of barium sulfate and Iodixanol and Iohexol was found ($p \leq 0.05$).

Discussion

When barium sulfate contrast agent 60% is used for gastrography to study various parts of the gastrointestinal tract separately, the process takes a longer time. However, when it is necessary to spend less time to study the digestive system, it is better to use Iodixanol the Iohexol.[17] The quality of observation phases are the same for the three agents, however, when Iohexol and Iodixanol contrast medium is diluted the quality of observation of different parts is too low and the study is not possible. The use of Iodixanol and Iohexol has some advantages including the followings: short time of passage through gastrointestinal tract, security, dilution to a ratio of 1:1 of the contrast, and especially iso-osmolarity of Iodixanol.[18] Short passage time makes it possible to diagnose faster and potentially reduces the pressure and the subsequent consequences resulting from animal control and containment.[19,20] Iodixanol and Iohexol are more expensive than barium, however as our study showed Iodixanol and Iohexol sample diluted at a ratio of 1:1 will reduce the cost of radiology. In addition, Iodixanol and Iohexol in all concentrations can help to observe gastrointestinal materials such as sand, while barium 60% provides a vague and invisible image of the content of gastrointestinal system. Iodixanol and Iohexol diluted by water with a ratio of 2:1 is not suitable which is consistent with the results of a study by Ernst et al., nevertheless, non-diluted Iodixanol and Iohexol or diluted by a ratio of 1:1 provides a contrast equal to that of barium sulfate.

In this study imaging times were increased to better study the samples and it was shown that contrast medium at the 5th minute entered the proventriculus, and ventriculus with a low opacity, however when using Iohexol the opacity was much better, and in a study conducted on parrots, no image was taken at the 5th minute and it was missed.[21] The diseases slowing down the activity of digestive tract, also reduce the amount of the materials passing though the gastrointestinal tract.[22] Moreover, eating too much can result in slower passage of materials though the vacant

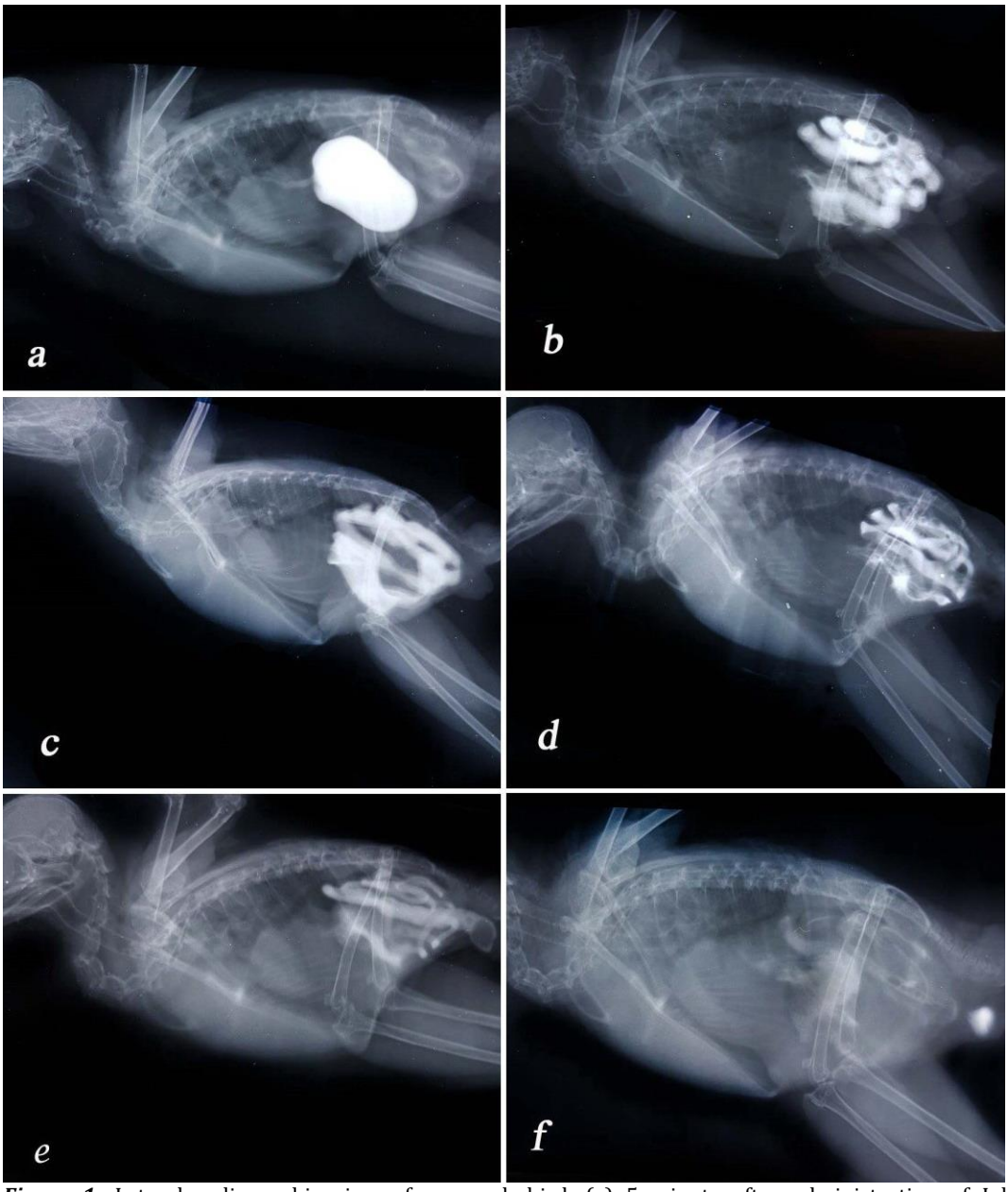

Figure 1: Lateral radiographic view of a mynah bird. (a) 5 minute after administration of Iohexol (b) 30 minute after administration of Iohexol (c) 60 minute after administration of Iohexol (d) 90 minute after administration of barium sulfate suspension (e) 60 minute after administration of barium sulfate suspension. Iohexol is equal to barium in radiographic quality of result. at the 90th minute, the amount of the contrast agent in the initial parts of cloaca, there is poor ability of the contrast agent to fill different parts of the cloaca.

Table 1: Scoring the ability of contrast agent to fill different parts of the gastrointestinal tract after ingestion the contrast agent.

Description	Score
Inability of the contrast agent to fill different parts of the gastrointestinal tract	0
Poor ability of the contrast agent to fill different parts of the gastrointestinal tract	1
Good ability of the contrast agent to fill different parts of the gastrointestinal tract	2
Excellent ability of the contrast agent to fill different parts of the gastrointestinal tract	3

Table 2: Scoring the clarity of gastrointestinal tract and visibility of different parts after ingestion the contrast agent.

Description	Score
Lack of increased clarity of gastrointestinal tract and visibility	0
Increased clarity of gastrointestinal tract and poor visibility	1
Increased clarity of gastrointestinal tract and good visibility	2
Increased clarity of gastrointestinal tract and excellent visibility	3

Table 3: Scoring the observation of shape, size, location, and mucosal details of gastrointestinal tract after ingestion of contrast.

Description	Score
Failure to observe the shape, size, location, and mucosal details of gastrointestinal tract	0
Poor observation of the shape, size, location, and mucosal details of gastrointestinal tract	1
Good observation of the shape, size, location, and mucosal details of gastrointestinal tract	2
Excellent observation of the shape, size, location, and mucosal details of gastrointestinal tract	3

gastrointestinal tract and the best results may be achieved in such a condition.[23,24] Despite not feeding the birds over the night, in our study we observed small filler materials (like food debris or sand) in the stomach and gizzard of the birds receiving Iodixanol and Iohexol. However, the passage of contrast medium was not affected.

Non-ionic iodine containing agents produce a milder inflammatory response than newer barium sulfate preparations or ionic iodine containing agents.[25] In addition, the non-ionic agents have far less effect on the blood gases and evoke less edema than ionic iodine containing agents.[26] Based on the results of studies on mammals, bird who inhale Iodixanol and Iohexol during contrast studies do not suffer from the effects of contrast agent. However, inhaling barium sulfate can hurt air bags and cause lung tissue damage. Because of the rapid passage of Iodixanol and Iohexol through the digestive tract. [27]

After the administration of Iohexol for the studied cats, the side effect of the drug (vomiting) was observed within 15-30 minutes. In cats, Gastrografin (diatrizoate sodium and dia¬trizoate meglumine) can cause opacification of the urinary tract; however, this did not occur in cats given iohexol for gastrointestinal contrast studies. Similarly. in our study. renal opacification was not observed in the birds after iohexol was administered orally. Undiluted iohexol caused vomiting in cats within 15 to 30 minutes after it was administered.' in our study, regurgitation. or aspiration. did not occur in any bird after iohexol or barium was administered. Although the contrast media did not directly cause regurgitation in the birds in this study, regurgitation can occur simply from the stress of the radiographic procedure and can result in aspiration.' Because iohexol is clear, regurgitation may not be immediately apparent to the clinician.[25] However, in the present study, no side effect such as vomiting, muscle tics, and other complications were observed. Williams *et al*. (1993) conducted a study to compare the use of gastrografin and barium sulfate and they showed that the passage time of the contrast agent through various gastrointestinal parts was quicker when using gastrografin, as compared with barium sulfate.[25] Ernst *et al*. evaluating contrast media administered to four Amazon parrots and one cockatoo, undiluted iohexol and iohexol diluted 1:1 with water provided radiographic visualization of the avian gastrointestinal tract equal to barium. They showed after each iohexol study was completed, all of the birds had a large volume of clear, watery droppings. They believed this was excreted iohexol, as opposed to true polyuria or diarrhea, but the content of these droppings was not determined. The color and consistency of the droppings also changed after the barium studies. However. although not confirmed. the white color of the

droppings indicated that barium was being eliminated.[24]

The contrast agents diluted at a ratio of 1-1 scored lower than the undiluted contrast agents, however they had no statistically significant difference in terms of the quality of observations and other scores ($p > 0.05$). The information obtained in this study can be used to investigate the complications of gastrointestinal tract of mynah and compare them with the normal ones. Iohexol is more expensive than barium; however, as shown in our study, a 1:1 diluted sample of iohexol will decrease the cost of use without sacrificing radiographic quality. Additionally, iohexol at all concentrations evaluated allowed visualization of intraluminal gastrointesti¬nal material, such as grit within the ventriculus, whereas barium (60% w/v) obscured the gastrointestinal contents.

Conflict of Interest

The authors declare that there is no conflict of interest.

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