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Case Report

Alterations of sex steroid hormone in an unusually sex-reversed duck: a case study

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A B S T R A C T

A two-year old female duck from Chattogram area of southern Bangladesh was found to develop unusual male phenotypic characters followed by a history of egg laying. This apparently sex-reversed duck was reportedly showed several visible changes including masculine body, appearance of drake feather, gradual changes in feather colour. During this study, we attempted to measure biochemical parameters to evaluate the case. These include knowing the alterations of sex steroid hormone concentration such as testosterone, estrogen, progesterone in sex-reversed duck. We isolated the duck and observed it for two weeks. The sex steroid hormones such as testosterone, estrogen, and progesterone concentrations were measured on day 0 (D0), day 7 (D7) and day 14 (D14) by using specific ELISA kit. Besides, an autopsy was performed to find out any gross changes in reproductive organs. We identified a gradual increase of male sex hormone testosterone from 1.88 ng/ml to 3.04 ng/ml from day 0 to day 14. The female sex hormones estrogen and progesterone has a decreasing trend in concentration (estrogen 110.2pg/ml to 85.3pg/ml; progesterone 2.5 ng/ml to 1.68ng/ml) from day 0 to day 14 of observation period. On postmortem examination, atrophied left ovary with no grossly visible ovarian follicle was found. The increasing concentration of male hormone and decreasing trend of female hormone might be associated with the sex-reversal phenomenon in this duck.

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1. INTRODUCTION

Sex reversal is a rarely occurring interesting event in biological fields (Shaikat et al., 2015). This event has been reported in domestic and zoo birds in nature including domestic fowl, pigeon, mallard, widgeon, pheasant, peahen, turkey, partridge, wood grouse, scaup, merganser and scoter (Forbes, 1947; Hamra et al., 2015). Experimentally, sex reversal has also been reported in chickens (Reyss-Brion et al., 1982; Valdez et al., 2010). In birds, sexual differentiation is a combination of direct genetic and hormonal mechanisms leading sex reversal whereas only genetic factor is subjected in mammals (Major and Smith, 2016). Sex reversal has also been encountered in amphibians, reptiles and fishes which is influenced by genetic-environment interactions and hormonal effects (Baroiller et al., 2016; Holleley et al., 2016). However, spontaneous sex reversal is a pathological condition in most of the cases in birds. The pathological conditions such as atrophy of left ovary, ovarian cysts or tumor,

adrenal diseases etc. are responsible for regression of the left ovary in birds (Riddle, 1924; Jacob and Mather, 2000). Arrhenoblastoma and exposure of pesticides such as nitrobenzene and dichlorodipheny-ltrichloroethane (DDT) cause atretic follicles in functional ovary in birds (Bigland and Graesser, 1955; Gupta and Langham, 1968; Shaikat et al., 2015). In presence of a regressed left ovary in birds, vestigial cortical tissues of the right ovary proliferate and develop as an ovotestis, leading to increase the levels of plasma testosterone and decrease the levels of plasma estrogen (Jacob and Mather, 2000). Sex reversal of female birds represent phenotypic secondary sexual characteristics like that of male due to increased levels of male hormone (testosterone). Present study was conducted to elucidate the alteration of sex steroidal hormones as well as phenotypic changes in a sex-reversed duck.

2. MATERIALS AND METHODS

Case description

A backyard farmer (having 10 female ducks) of Chattogram, Bangladesh presented one female Khaki Campbell duck of 2 years which has a history of egg laying (120 eggs) has suddenly stopped egg laying. The farmer also claimed that there was changes in phenotypic characters of that female duck including changes in body shape to masculine, appearance of drake feather, gradual changes of feather colour (intensification) at head, neck, and wing region (Figure 1). The duck also has changed its usual voice. The duck was isolated for two weeks for observation after the case presentation.

Figure 1: Changes in phenotypic characters in sex reversed duck

Serum preparation

Blood was collected from jugular vein and 3 ml of blood was transferred to a vacutainer (without anticoagulant) on day 0 (D0), day 7 (D7) and day 14 (D14). The blood was kept in room temperature for 4 hours for smooth coagulation and serum was collected through centrifuging at 3000 rpm for 30 minutes. The separated serum was stored in a 1.5 ml tube and kept in -20°C freezer before further use.

Hormone assay

The sex steroid hormones such as testosterone, estrogen and progesterone on D0, D7 and D14 has been analyzed using specific ELISA kit. The procedures were performed according to manufactures instruction of the respective ELISA kit (For testosterone: BIOS Microwell diagnostic system, The Netherlands; For estrogen and progesterone: NovaTec Immundiagnostica GmbH, Germany). The absorbance was read in ELISA reader (Bio-Rad, USA). The four parametric logistic curve fit was performed to analyze hormone concentration.

Postmortem inspection

The duck has been sacrificed by halal slaughter and postmortem examination was done.

3. RESULTS

Measurement of the sex steroid hormone concentration in the sex reversed duck on three respective days as D0, D7 and D14 was assessed. This has been done to get the idea on possible changes of sex steroid hormone concentration. The data indicates that the male hormone i.e testosterone has an increasing trend of concentration from D0 to subsequent days. Besides that, estrogen and progesterone concentration have a decreasing trend from D0 to the following days (Figure 2). On postmortem inspection, the viscera and other internal organs was found as normal except the left ovary that was atrophied with no apparently visible ovarian follicles (Figure 3).

4. DISCUSSION

Sex reversal cases in birds have been sporadically reported by several investigators in different geographical regions among different species. The reversal of sex in duck was first

reported in an Indian Runner breed at Australia which was transformed into male from female (Hart, 1936). That duck had small ovary of 4 square centimeters with non-developed oocytes. This type of phenomenon is also found in our studied duck. Present report is first of its type in duck in Bangladesh.

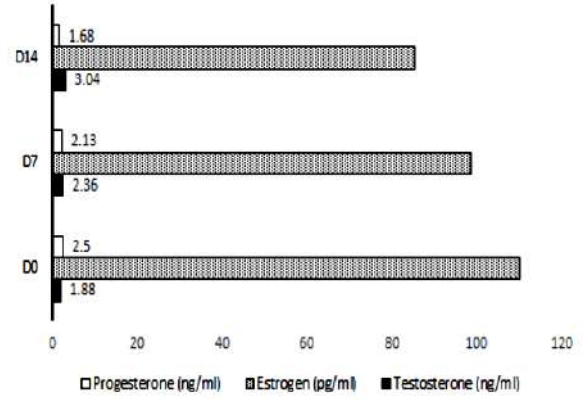

Figure 2: Sex steroid hormone alteration in sex reversed female duck at D0, D7 and D14

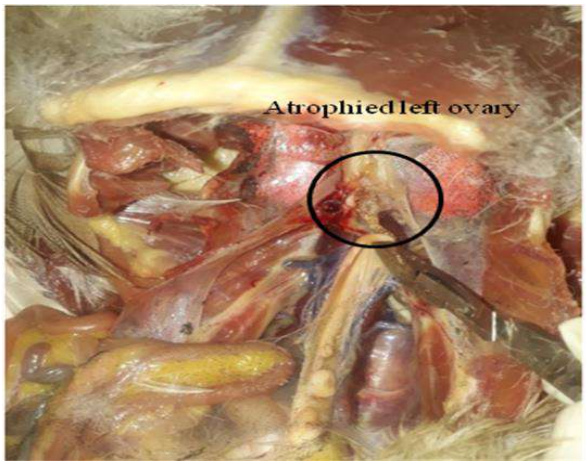

Figure 3: Atrophied left ovary with no grossly visible ovarian follicle

The sex chromosomes in the birds are Z and W; ZZ is a male and ZW will express female phenotypes. The sex reversal in birds can be spontaneous or induced; also achieved by treatment like aromatase inhibition (Major and Smith, 2016). In a previous report, the aromatase inhibitor-treated female birds showed spermatogenesis in adult life (Elbrecht and Smith, 1992). As the studied female duck has laid around 120 eggs before the sexual reversal, this sex reversal could be a spontaneous case. Our studied female duck has changed in voice as male duck produce. Notable that, estrogen plays a vital role in production of female voice (Abitbol et al., 1999). The change of voice to male sound could be related with decreasing trend of estrogen concentration (D0: 110.2 pg/ml, D14: 85.3 pg/ml). Being homozygous, the ZZ is dominant in bird which can suppress the estrogen. In case of experimentally estrogen injected chicken male embryo, the female gonadal system is developed. However, it has turned into the male gonad upon the cessation of the estrogenic therapy. So, estrogen could play a pivotal role in sex determination (Guiguen et al., 2010; Major and Smith, 2016). Owens and Short (1995) stated that the removal or pathological destruction of female gonad due to disease may cause sudden change of sex in adult birds. This finding are also supported by the series of experiment performed by Riddle (1924) who found that the tuberculosis may suppress the female gonad in pigeon which may cause the bird to show male signs. Though there is no presence of signs of tuberculosis or any other diseases in the studied bird as presented in autopsy, but this duck has showed the trend of decreasing estrogen and increasing testosterone concentration. The increasing testosterone level can be caused by the probable regeneration of right gonad which could convert into ovo-testes and produce male hormone as left ovary atrophied (Jacob and Mather, 2000). In our study, though we observed the increasing trend of testosterone and decreasing trend of estrogen, we could not verify whether the right atrophied gonad has become steroidogenically functional and secret androgens, as well as estrogen.

5. CONCLUSIONS

While it remains inconclusive that an external endocrine disruptor or other product has stopped the female gonad to function or the left gonadal function is disrupted, further study can reveal this unusual case. We have no report of exposure of endocrine disrupting chemicals in our studied backyard ducks from feed or other sources. In conclusion, this study indicates the occurrence of a spontaneous sex reversal in a duck which has sex steroidal hormone alteration.

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