XO—Gonadal Dysgenesis in the Mare
(Report of Two Cases)

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THE development of techniques for chromosome analysis in man and animals has stimulated interest in their application to problems of infertility. Chromosome preparations are made from blood lymphocytes or from fibrous tissue cultures obtained from skin biopsies. The former is a rapid and convenient source but it provides only a limited number of cells. Fibrous tissue cultures, on the other hand, can be maintained for long periods and large numbers of metaphase plates can be examined. The division of cells is arrested by colchicine, then they are distorted by hypotonic solutions to disperse the chromosomes before being placed onto slides and stained. Suitable metaphases are photographed and the chromosomes cut out of the prints and arranged in pairs according to their morphologic features, e.g., length, position of centromere, etc. (Sharma, A. K. and Sharma, A., 1972). A number of reports in man on phenotypic females with an abnormal sex complement, usually a chromosome number of 45 and an XO sex chromosome constitution (Turner, 1938; Hecht, et al., 1969; Polani, 1961; Santesson, Böök and Kjessler, 1973; Sohval, 1965; Stempfel, 1969). Sohval (1965) divided these individuals into three groups. Subjects with vestigial streak gonads, normal but underdeveloped genitalia, and an assortment of somatic abnormalities, i.e., short stature, webbing of the neck, shield-like chest, skeletal and cardiorenal abnormalities. This syndrome was described by Turner in 1938, and hence is called "Turner's Syndrome". When the vestigial streak gonads exist alone and the adult is of normal stature or tall with eunuchoidal proportions, it is called a "pure gonadal dysgenesis". When the typical somatic congenital defects occur but are not accompanied by gonadal involvement, it is termed "Ulrich Syndrome".

It has been estimated in man that 96 to 98 per cent of all XO conceptuses are eliminated in utero (Hecht, et al., 1969), although the reasons for this high rate of embryonic loss are unknown. Individuals with vestigial streak gonads are infertile due to the absence of germ cell elements in this non-functioning remnant. Although infertility has been associated with other syndromes, having abnormalities in sex chromosome complement (Polani, 1961; Sohval, 1965; Bornstein, 1967; Stempfel, 1969; Hecht, et al., 1969; Santesson, et al., 1973), XO mice are viable, fertile and phenotypically normal (Morris, 1968).

Aneuploidy in an infertile mare was reported (Payne, et al., 1968). The chromosome count was 63 and normal X chromosomes could not be identified. This paper reports on the chromosome analysis and clinicopathological features of two cases of XO gonadal dysgenesis in mares.

Case Number 1

A 6-year-old Quarterhorse mare, 140 cm high and weighing 386 kg, but a normal phenotypic female. She was smaller than either her sire or dam and had never showed oestrus despite being teased regularly. The external genitalia were normal with no enlargement of the clitoris. The uterus was flaccid and smaller than normal. The cervix was completely flaccid, but occasionally the os was dilated and it was possible to look directly into the uterus. The vagina was of normal size and appearance, and mucous secretions were sticky in character and scant in amount. The ovaries were very small and smooth, with a firm texture and no palpable follicles. They weighed 5.5 and 5.7 g respectively, and measured 30 mm x 15 mm x 14 mm, as compared to the ovary of a normal dioestrous mare which weighs 48-65 g and measures 75 mm x 40 mm x 30 mm (Warszawsky, et al., 1972) (fig. 1).

Peripheral plasma luteinizing hormone (LH) levels were determined by radioimmunoassay. These were significantly increased above normal, being 2.4 ng/ml as compared with control levels of 0.4 ng/ml in a dioestrous mare 6 days postovulation; LH levels did not change significantly after ovariectomy. (Geschwind, I., personal communication).

Glucose-6-phosphate dehydrogenase (G6PH) levels were 958 IU/100 g Hb as compared to normal values of 765 ± 192 IU/100 g Hb (Kaneko, Tanaka, Nakajima and Ushimi, 1969). Recovery of adrenal function after inhibition with a suppressing dose of dexamethasone given intravenously (10 mg per kg of bodyweight) was normal.
Polymorphonuclear leukocytes were examined from smears of the peripheral blood and no sex chromatin appendages ("drumsticks") were noted in 1000 cells counted, as compared to 20/480 (4 per cent) in a normal control mare and 0/500 in a gelding.

The ovaries (fig. 2) consisted of stromal tissue only and there was considerable pigment in the medullary zones. In the hilar portion of one gonad were clusters of cells which had a pale foamy cytoplasm and were suggestive of adrenal origin.

Skin biopsies were grown in tissue culture and prepared for chromosome analysis. Forty-nine spreads were karyotyped: 44 of these were 63, XO, and 5 had irregular losses or gains of elements. Radioautography failed to detect a clone of normal cells (fig. 3).

**Case Number 2**

Case Number 2 was a 6-year-old Appaloosa crossbred, 135 cm high and weighed 318 kg, but a normal phenotypic female. This animal had been mated on several occasions and her response to the teaser varied from passive to positive signs of oestrus. There was no cyclic pattern to her oestrous behaviour and she would show signs of oestrus for days and then become passive for extended periods.

The external genitalia were normal with no clitoral enlargement and the vulva and vagina were of normal size and appearance. The uterus was small, but not infantile, and flaccid on rectal palpation. Examination by speculum revealed a pale, tight, dry cervix with sticky mucus characteristic of a mare in dioestrus. The ovaries were extremely small with a smooth, firm texture and no palpable follicles. The right ovary weighed 0.25 g and measured 12 mm x 5 mm, and the left ovary weighed 1.2 g and measured 18 mm x 13 mm x 12 mm (fig. 4).

Plasma LH levels were within the normal range (0.4 ng/ml) and were unchanged 14 days after ovariectomy. Glucose-6-phosphate dehydrogenase levels were within normal limits (946 IU/100 g Hb) as was recovery of adrenal function after inhibition with dexamethazone.

Sex chromatin appendages ("drumsticks") were noted in 18/1030 (1.75 per cent) polymorphonuclear leukocytes counted, as compared to 20/480 (4 per cent) in a normal control mare.

Multiple sections of each ovary were examined histologically, and as in Case 1, no ovu were seen. The gonads consisted primarily of undifferentiated ovarian
Two cases of XO-gonadal dysgenesis in the mare are presented. Case No. 1 was a pure 63, XO, while Case No. 2 was a mosaic with a preponderance of XX cells. The clinical picture was one of phenotypically normal female mares with small, inactive ovaries lacking germ cells. The mares in this study had two types of sex chromosome anomaly, Case 1 had only a single X chromosome and Case 2 had XO/XX mosaicism with approximately 35 per cent of cells showing only one X chromosome (63, XO). This is similar to man where a large percentage of surviving Turner's syndrome patients are mosaic with a clone of XX cells (Polani, 1961; Sohval, 1965; Bornstein, 1967; Carr, 1969; Hecht, et al., 1969; Stempfel, 1969; Santesson, et al., 1973). It is not known to what extent mosaicism differed in various tissues of this mare.

The mare reported by Payne, et al. (date 1968) as having a chromosome count of 63 varied considerably from our two cases. She showed follicular development and ovulated, whereas our mares had small, inactive ovaries lacking germ cells.

It has been estimated in man that 96 to 98 per cent of all XO conceptuses aborted (Hecht, et al., 1969) and that about 30 per cent of surviving Turner's syndrome patients are mosaics (Hecht, et al., 1969; Santesson, et al., 1973). It therefore seems feasible to suggest that mosaicism may provide a survival advantage in utero and this would correlate with the failure to find X chromosome mosaics among abortuses (Hecht, et al., 1969).

**SUMMARY**

Two cases of XO-gonadal dysgenesis in the mare are presented. Case No. 1 was a pure 63, XO, while Case No. 2 was a mosaic with a preponderance of XX cells. The clinical picture was one of phenotypically normal
female mares with small uteri and infantile ovaries. The ovaries lacked germ cells, and consisted of stroma only. This study emphasizes the importance of chromosome analysis in providing information concerning the mechanisms involved in some cases of equine infertility.

RESUME
Deux cas d’anomalie de ce type sont presents. Le cas No. 1 est un pur X O, le cas No. 2 est du type en mosaïque avec prépondérance de cellules XX. Cliniquement il s’agissait de femelles normales avec de petits utérus et des ovaires infantiles. Les ovaires étaient dépourvus de cellules germinatives. Cette étude souligne l’importance des analyses chromosomiques dans l’interprétation de certaines infertilités.

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