GONADAL DYSGENESIS, TURNER'S SYNDROME AND PHENOTYPE IN THE SOUTH AFRICAN BANTU*

H. J. GRACE, *Genetics Department, Natal Institute of Immunology, Durban*

The South African population is composed almost entirely of four races, the negroid Bantu; white Caucasoids; Asiatic Indians; and, of mixed origin, the Coloureds. Congenital anomalies of sex development are known to affect each of the races but it is interesting that the prevalence of various intersexual conditions shows discernible inter-racial variation. Experience in the Witwatersrand area[6,36] and in Rhodesia[10] has shown that hermaphroditism is the commonest form of intersex in the Bantu of those areas, while gonadal dysgenesis is rare,[20] there being only a single mention of an infant with the Bonnevie-Ullrich syndrome and the 45,X karyotype.[25] By contrast, hermaphroditism is exceptional and gonadal dysgenesis of females is relatively common in the Bantu of Natal.[13] Eight patients, all Bantu of the Zulu nation, are reported in this article: 6 had gonadal dysgenesis and 2 the female Turner phenotype.

CASE REPORTS

Case 1 (Infantile Turner Phenotype)

A new-born baby was transferred to hospital from a peripheral maternity clinic for investigation of 'deformities of the spine, hands and feet'. The patient was the product of a full-term, uncomplicated pregnancy of a 23-year-old primigravida. There was no relevant family or medical history.

The infant (Fig. 1) was aged 6 hours, and weighed 2 777 g at birth. She had cutis laxa of the neck, a low posterior hairline, flattened occipital contour and abnormally folded pinnae. The chest was broad and flat with widely spaced hypoplastic nipples. The dorsal aspects of both hands and feet were oedematous. There were no obvious abnormalities of the external genitalia or skeleton. Heart sounds were normal and the chest was clear.

When aged 10 months the infant was readmitted to hospital with acute bronchopneumonia, and died 48 hours later. Postmortem examination confirmed the cause of death and also showed gross hyperplasia of the left ventricular wall. There was no obvious cause for this apart from mild hydronephrosis of the right kidney. There was no coarctation of the aorta or other great vessels. The internal genitalia (Fig. 2) consisted of a small uterus, fine fallopian tubes and streak gonads. Histological examination of the gonads showed only poorly developed stroma without follicles.

At birth and again at 10 months of age, only the 45,X karyotype was found in cultured peripheral blood lymphocyte chromosomes. Buccal epithelial nuclei were sex-chromatin negative. Radiographs showed nothing unusual in the skeleton. Hormone studies were not done.

Case 2 (Turner's Syndrome)

A 36-year-old staff nurse had never menstruated until she was given oestrogen therapy at the age of 28 years.

Examination showed a short, obese female: she was 137 cm tall and weighed 68 kg; armspan was 130·5 cm. The occiput was flattened, with a low scalp margin on the

Date received: 31 July 1970.

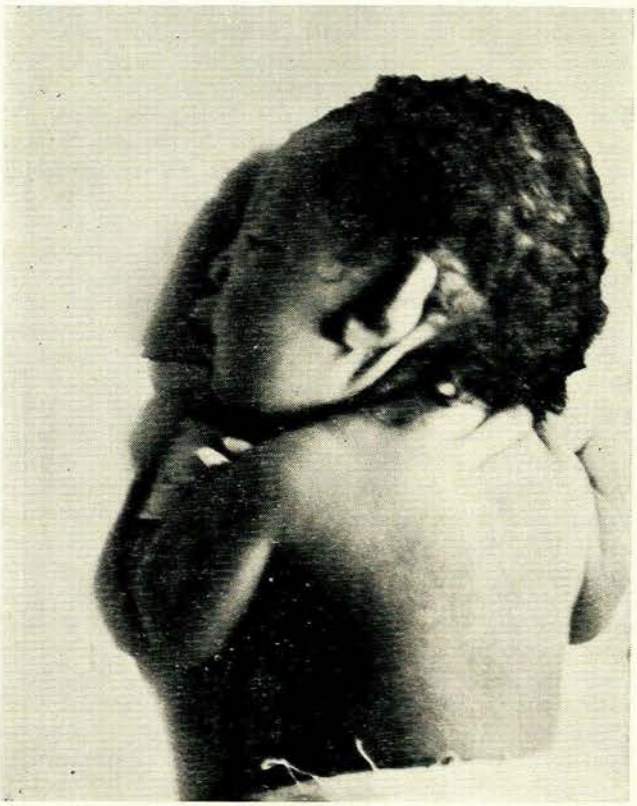

Fig. 1. Case 1.

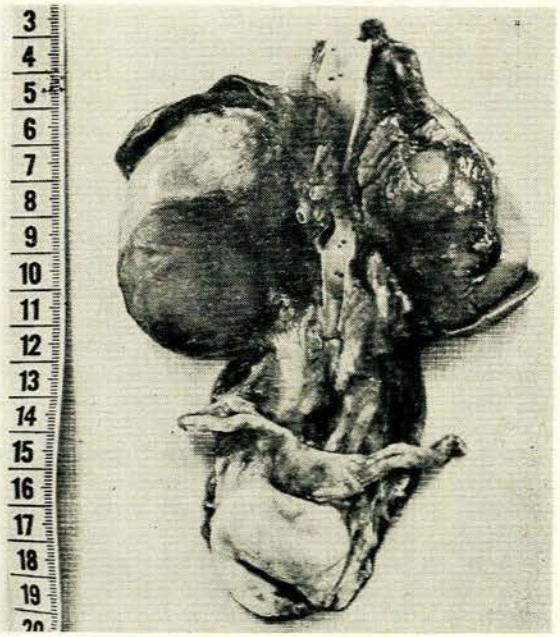

Fig. 2. Case 1. Internal genitalia and kidneys: note right hydronephrosis.

nape, and the neck was webbed. Her chest was wide and box-like with sternal excavation. The breasts were widely spaced and poorly developed, with hypoplastic nipples (Fig. 3). Cubitus valgus was seen in both arms. All her

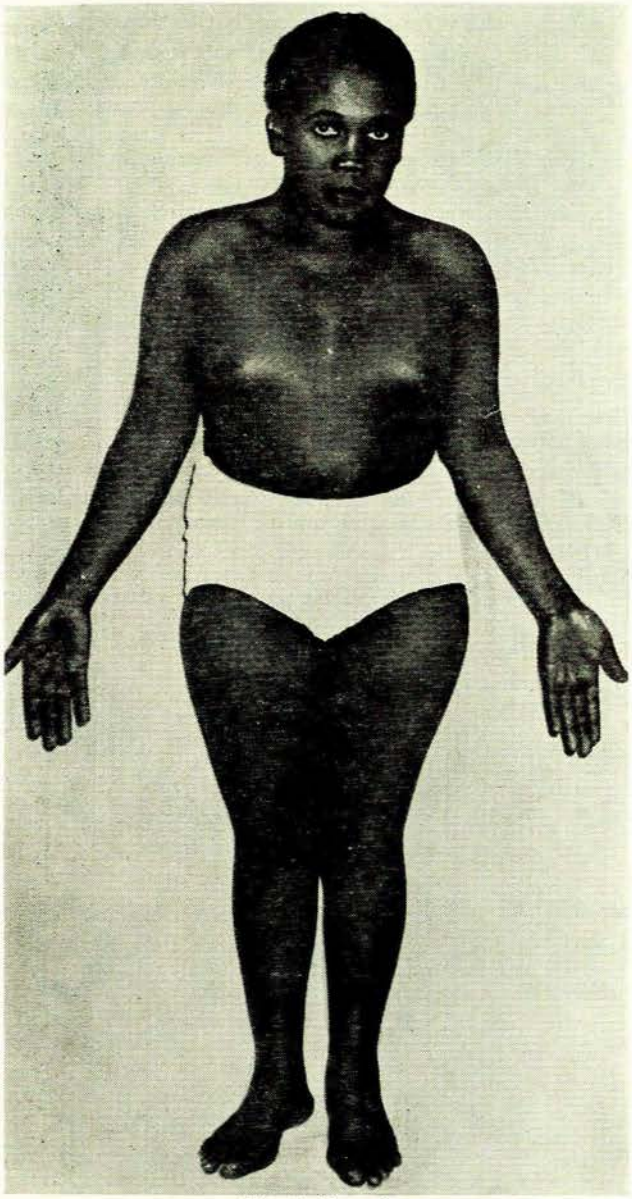

Fig. 3. Case 2.

fingers were exceptionally long. The left fourth toe was short. The external genitalia were infantile: the labia were flat, the clitoris was small, and the vagina was narrow. Bimanual and rectal palpation disclosed a small cervix; the uterus and its adnexae were not felt. The heart and lungs were normal. The patient was intelligent. She had never had any sexual experience.

Karyotypes were all 45,X and no sex chromatin was seen in oral mucosal nuclei. Radiological studies showed the classic signs of gonadal dysgenesis: there was extensive osteoporosis in the cervical spine, buttressing of the supracondylar ridges of both humeri, and overgrowth of the medial tibial condyles with rat-tooth exostoses.

Case 3 (Turner's Syndrome)

A 22-year-old female presented at hospital complaining of primary amenorrhoea. She was 154 cm tall, with eunuchoid proportions: armspan was 167 cm and the ground to pubis distance 82 cm. Her weight was 51·25 kg. The disproportionate appearance was exacerbated by hemiatrophy of the left side. Her occipital hairline was low. The neck was webbed and the left shoulder was about 3 cm lower than the right shoulder (Fig. 4). Micrognathia was associated with a highly arched, narrow palate. There was no breast tissue; the nipples were small, hypoplastic and widely separated. Both arms were noted to be long with increased carrying angles. The hands were essentially normal. Her pelvic contour was adolescent. Both feet had wide spaces between the first and second toes and there was extreme hypoplasia of the remaining digits (Fig. 5).

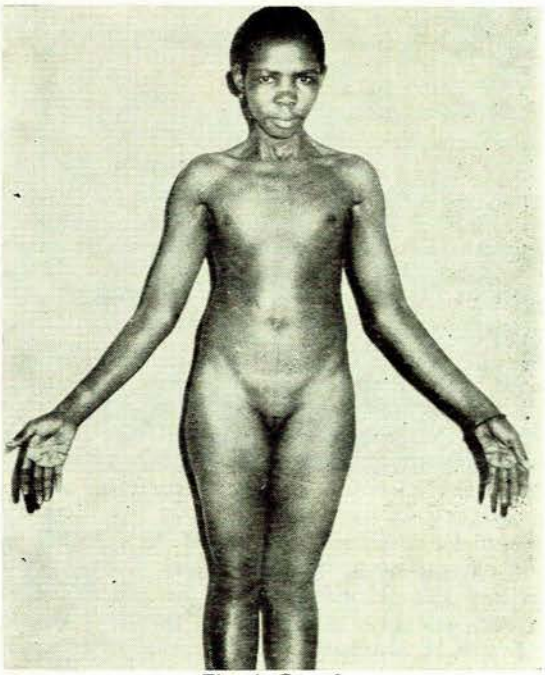

Fig. 4. Case 3.

The external genitalia were infantile. Secondary sex development was restricted to a sparse growth of hair about the pudenda. The vagina was narrow and admitted only 1 finger. Although her mental state and intelligence appeared to be normal, the patient had no heterosexual desires.

Bimanual palpation of the internal genitalia was impossible because of her narrow vagina. Laparotomy revealed a small uterus with thin fallopian tubes and bilateral streak gonads. Histological examination of gonadal tissues showed only scant ovarian stroma with no follicular elements. Chromosome analysis established that there was mosaicism of 45,X and 46,XX cell lines, in equal proportions. The buccal mucosal sex-chromatin count was 27% positive. Radiographs showed mild osteoporosis of the vertebrae, but no other features of gonadal dysgenesis.

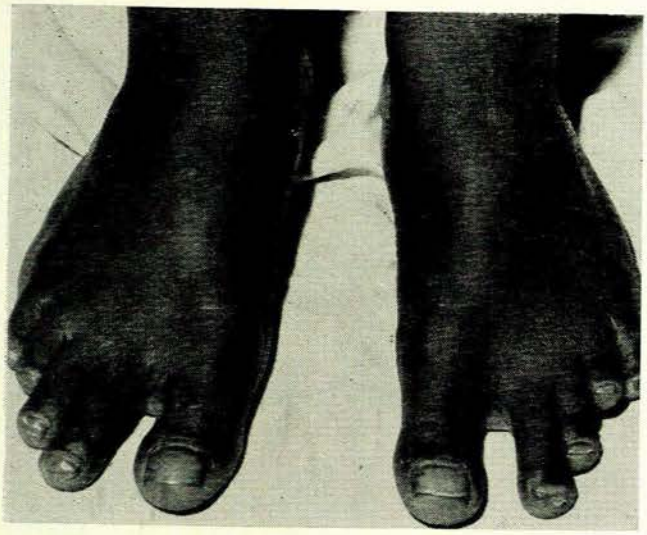

Fig. 5. Feet of case 3 showing space between digits I and II; also hypoplasia of digits III, IV and V.

Case 4 (Pure Gonadal Dysgenesis)

The patient was an elderly woman, approximately 60 years of age, who was admitted to hospital for treatment of acute bronchopneumonia, malnutrition and cor pulmonale. Questioning disclosed that she had never menstruated, had never had any heterosexual desires and had lived a secluded life. The patient was 168 cm tall and claimed always to have been of slender build. Her armspan was 167 cm. The chest was wide, with pectus excavatum. Breast development and other secondary sexual features were lacking; there were no other signs of Turner's syndrome. Radiographs demonstrated kyphosis of the thoracic spine, due to osteoporotic changes of the vertebrae. It could not be established whether or not this was due to senile degeneration or to the osteoporosis of gonadal dysgenesis.

Cytogenetic investigation revealed 45,X/46,XX mosaicism in cultured lymphocyte karyotypes. The sex-chromatin count was 33%. In deference to the patient's advanced years and deteriorating health no further investigations were felt to be justified.

The patient died in renal failure and a postmortem inspection of the internal genitalia showed that the uterus was small; the fallopian tubes were long and thin and the gonads were represented by pale streaks. There were no anomalies of the heart and great vessels. Histological examination of the gonads showed only connective tissues; there was no evidence that germinal elements had ever been present.

Case 5 (Turner's Syndrome Variant)

A 20-year-old female was admitted to hospital for investigation of primary amenorrhoea. She was exceptionally short, her height being 128 cm, with ground to pubis distance 67 cm and armspan 138 cm. She was moderately obese and weighed 39 kg. Her occipital contour was flat and the hairline was low down the neck. She had a highly arched, narrow palate and micrognathia but there was no malocclusion of the teeth. The left clavicle was oddly shaped. Her chest was broad, with sternal excavation; there was lipomastia, and the hypoplastic nipples were widely separated. Both elbows showed marked increase of the carrying angle; the hands and fingers were normal. On both feet digits III, IV and V were noticeably short. The external genitalia were infantile and there was no pubic or axillary hair. The pelvic contour was not feminine. Mentally the patient was alert and had passed Standard 2 before leaving school to work as a domestic. She claimed to have a boyfriend but in spite of mutual attraction there had not been any sexual contact.

Lymphocyte karyotypes revealed mosaicism of 45,X/46,XX karyotypes in the proportions 90:10. An oral mucosal smear was sex-chromatin negative. Radiographs demonstrated rat-tooth exostoses of the medial tibial condyles and hypoplasia of metatarsals III, IV and V. Peritoneoscopy revealed a small uterus with thin fallopian tubes, a streak gonad on the left side and a tiny knob of pale tissue at the site of the right gonad. No biopsy specimens were taken.

Case 6 (Female Turner Phenotype)

The patient, aged 24 years, was admitted to hospital at 40 weeks' gestation for delivery of her first infant. On admission she was noted to be of odd appearance and it was decided to do genetic studies subsequent to her confinement.

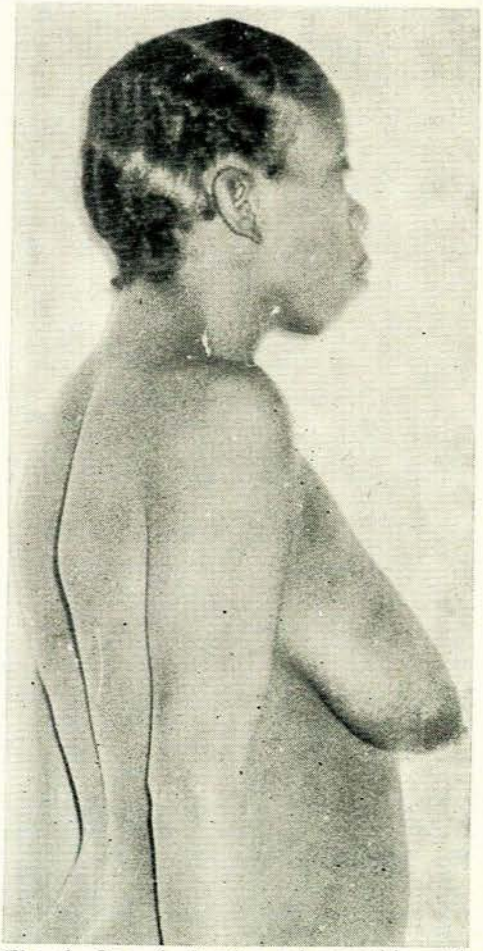

Fig. 6. Case 6 showing micrognathia and low hairline.

The patient was only 145 cm tall; the ground to pubis distance was 77 cm and the armspan 149 cm. A week after delivery her weight was 60·6 kg. The occipital contour was flat and the posterior scalp margin was very low (Fig. 6). Clinically, spinal kyphosis was observed but this was not confirmed on radiographs. Her neck appeared to be short and was webbed. Micrognathia and hemiatrophy of the right side of the face gave the patient a peculiar expression; the typical 'fish mouth' was evident. Both clavicles were abnormally shaped and the chest was wide, with pectus excavatum. The breasts were pendulous with the nipples situated medially. Lactation occurred normally. The humeri were short, and the carrying angle of the right arm was slightly increased. The pelvis was android in shape. Except for hypoplasia of the right 4th toe there were no abnormalities of the legs or feet. Secondary sex characteristics were not well developed: there was no axillary hair; the pubic escutcheon, which followed feminine limits, was very sparse, and there was no deposition of subcutaneous fat over the buttocks and thighs. The clitoris was small. The patient was of very low intelligence and was uneducated. She was not married, but claimed to know who was the father of her child.

Cytogenetic investigation revealed no overt chromosomal anomaly and the karyotype was apparently normal, 46,XX. The sex-chromatin count was 36%. There was no radiographic evidence of hemiatrophy. Mild osteoporosis was seen in the thoracic vertebrae. During caesarean section it was noted that both ovaries were of normal appearance; they were not biopsied.

Case 7 (?Female Turner Phenotype)

Baby S was delivered by caesarean section of a young primipara (see case 6, above) because of cephalopelvic disproportion.

At birth the general condition of the patient was satisfactory. She weighed 1 920 g; crown-rump length was 23·0 cm and armspan 34 cm. The head and chest circumferences were 28·6 cm and 25 cm, respectively. The forehead receded and the occiput was flat. The hairline on the occiput was low and there was some redundant skin about the neck. The ears were low-set with small, abnormally folded pinnae. The palate was highly arched and narrow. The chest was box-like with sternal excavation. A wide space separated the nipples. A spinal dimple was located over the sacral spine. No skeletal abnormalities were noted. Both palms had aberrant flexion creases.

On the 14th day clinical signs suggestive of intestinal obstruction appeared and on day 18 laparotomy was performed. Complete rotation of the gut was revealed; the caecum and vermiform appendix being in the left epigastrium. No obvious cause of obstruction was found. The postoperative course was unsatisfactory and the baby died 4 days later.

Postmortem dissection showed that the surgical wound had healed well. All the cranial and thoracic organs were essentially normal. The stomach was normal but the bowel was rotated. A small pedunculated polyp, about 4 mm in diameter, was found in the duodenum but was not thought to have caused an obstruction. The large bowel was irregularly coiled and a 6-cm-long loop of the sigmoid colon was found in the left iliac area: this loop if occluded by pressure from the gut contents, could have caused symptoms of intestinal obstruction. The rectum and anus were both normal. Macroscopically the liver, pancreas, spleen, adrenal glands and urogenital structures were normal.

Microscopic examination of postmortem tissues showed signs of liver damage. Hepatic cells showed fatty infiltration and their nuclei were displaced to the cell walls. Kupffer cells were very prominent and there was some inflammatory cell invasion. Biliary caniculi and ducts contained bile thrombi. Many primordial follicles were seen in the ovaries. There were no remarkable changes in any other organ. The pathologists' conclusion was that liver damage had been caused by anaesthetics administered to the mother for the caesarean section, and exacerbated by further anaesthesia when the baby itself was subjected to surgery. The origin of signs which suggested intestinal obstruction, anorexia and vomiting was not determined and the possibility remained that they were manifestations of a biochemical disturbance as a sequel to liver damage.

Before death cytogenetic investigation had established that the karyotype was that of a normal female, and the sex-chromatin count was 17%. The general appearance of the patient, however, suggested that, like her mother, she had the female Turner phenotype.

Case 8 (Pure Gonadal Dysgenesis)

A 24-year-old schoolmistress was admitted to hospital for investigation of primary amenorrhoea. She was tall and slightly obese, her height being 165 cm and her weight 63·95 kg. Armspan was 177 cm. Her secondary sexual development was poor: the breasts were small and lipomastic, with hypoplastic nipples. The vagina was dry and narrow, the clitoris small, and sexual hair sparse. She claimed to be attracted to men but had never had any sexual desire.

Internal genitalia could not be palpated. Peritoneoscopic examination showed a small uterus, together with fine fallopian tubes and bilateral streak gonads. No gonad biopsy specimens were taken. Chromosome analysis produced only normal female karyotypes, and the buccal epithelial nuclei were 34% positive for sex chromatin.

Dermatoglyphic Studies

Finger and palmar dermatoglyphic features of cases 1 - 8 are presented in Table I and Fig. 7.

TABLE I. DERMATOGLYPHIC PROFILES OF PATIENTS

Case No.	Fingertip pattern L* V - I	Fingertip pattern R I - V	TRC R+L	Angle atd L	Angle atd R	a-b count R+L	Position of t L	Position of t R
1	LLLLL†	LLLLL	189	75	73	91	t″	t″
2	LLLRW	WLLLL	180	41	42	107	t	t
3	LWLLL	LLLLL	168	44	47	72	t′	t′
4	Not done							
5	LLLAL	LLLLL	91	36	41	41	t	t
6	ALAAA	AAALA	12	68	63	101	t″	t″
7	Not discernible							
8	LLLAA	ARALL	49	39	39	74	t	t

Note: Main line exits, thenar and hypothenar patterns and flexion creases are shown in diagrams (see Fig. 7).

*L = left hand; R = right hand.
†L = loop ulnar; W = whorl; R = loop radial; A = arch.

DISCUSSION

'Gonadal dysgenesis' is a generic term for those disorders of development in which the gonads are represented only by connective tissues and have no germinal elements. By common usage the term has, unless qualified, come to

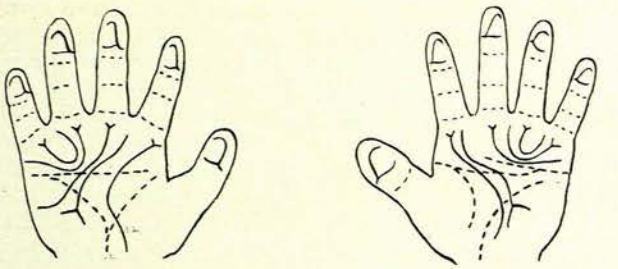

Fig. 7(a). Finger and palmar dermatoglyphic features of case 1.

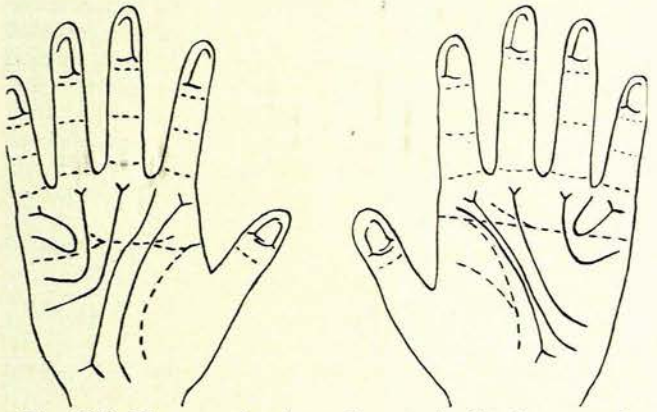

Fig. 7(b). Finger and palmar dermatoglyphic features of case 2.

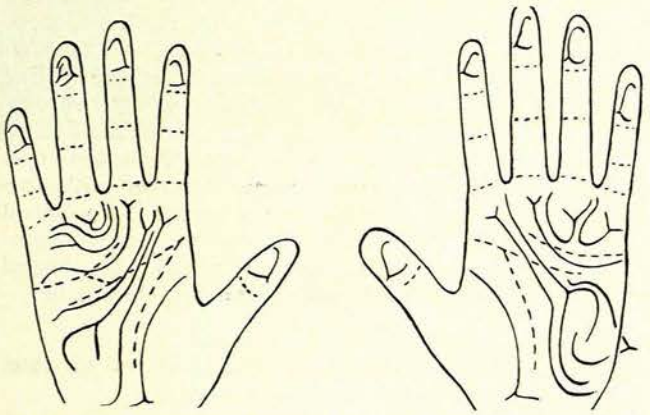

Fig. 7(c). Finger and palmar dermatoglyphic features of case 3.

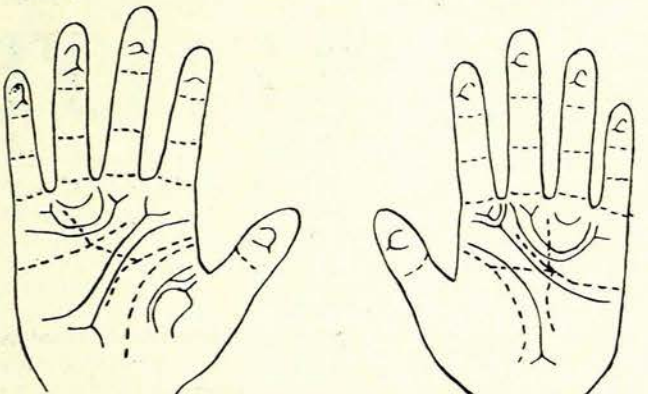

Fig. 7(d). Finger and palmar dermatoglyphic features of case 5.

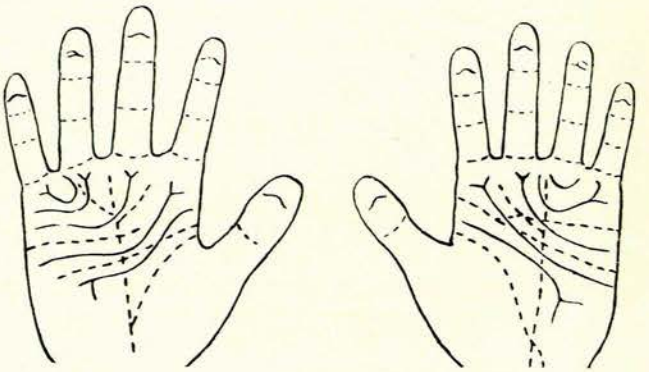

Fig. 7(e). Finger and palmar dermatoglyphic features of case 6.

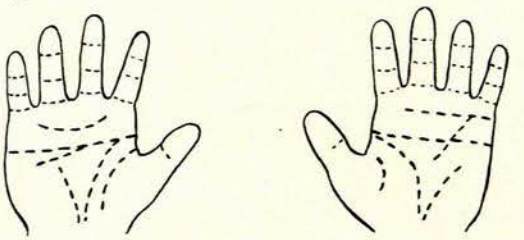

Fig. 7(f). Finger and palmar dermatoglyphic features of case 7.

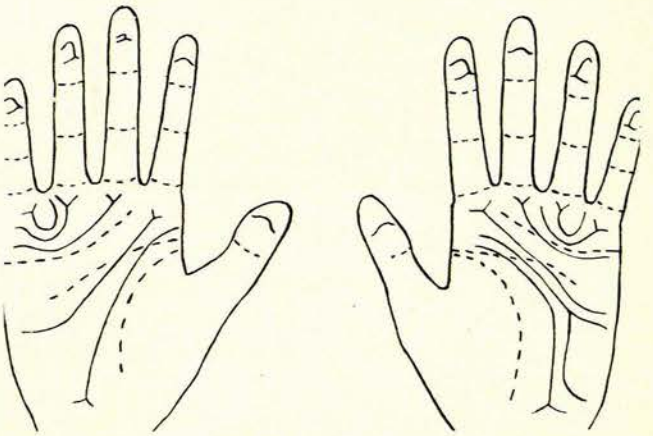

Fig. 7(g). Finger and palmar dermatoglyphic features of case 8.

refer to the female; similar problems of the male should be considered separately. During recent years there has been a tendency to use the generic term and Turner's syndrome synonymously, a most unfortunate and inaccurate practice which has certainly contributed to the present confusion in the use of the eponym.

Gonadal dysgenesis presents a bewildering array of phenotypes, which makes it imperative that the nomenclature be used accurately. Affected individuals may be of normal or short stature and they may or may not have any somatic abnormalities. Also, a very wide range of karotypes has been identified with gonadal dysgenesis. In fact, the only constant feature among affected persons is gonadal dysgenesis.

Classification

The major categories which can be recognized in gonadal

dysgenesis may be summarized as follows:

1. Normal stature, no abnormalities (pure gonadal dysgenesis).
2. Normal stature with somatic abnormalities (unnamed syndrome).
3. Short stature, no abnormalities (Rössle's syndrome).
4. Short stature with somatic abnormalities (Turner's syndrome).

A brief summary of these groups is presented here; for extensive detail the reader is referred to some of the many publications on gonadal dysgenesis.[3,6,14,17,27]

1. *Pure gonadal dysgenesis* occurs in females of normal stature with no extragenital abnormalities. Secondary sex development is usually better than in the other syndromes, there being more pubic and axillary hair; a larger uterus; and in occasional patients, slight, spontaneous breast development.[5] The majority have apparently normal female karyotypes but an identical type has normal male chromosomes. The syndrome was first recognized in chromatin-negative (male) subjects[32] and was named 'pure gonadal dysgenesis'.[16] The female version was described later.[22]

2. *Normal stature with somatic abnormalities* is an uncommon combination in gonadal dysgenesis. Thus, Hauser[17] described such a patient, while mention was made of patients with pure gonadal dysgenesis in whom isolated Turner stigmata were seen.[21]

3. *Rössle's syndrome* consists of gonadal dysgenesis in patients of short stature but in whom there are no extragenital anomalies.[27]

4. *Turner's syndrome* was originally described as the association of infantilism, webbed neck and cubitus valgus in females of short stature. A number of other somatic abnormalities[25] are so frequently associated with the primary signs that it has become acceptable to extend the definition of Turner's syndrome to include females of short stature with gonadal dysgenesis and somatic abnormalities;[8] those who lack one or other of the primary signs may be described as variants of the syndrome. The karyotype may be normal (46,XX); or a mosaic of 2 or more cell lines; or consist purely of 45,X cells. This is the commonest form of gonadal dysgenesis.

Of the clinically related, or confused, syndromes which are frequently mentioned in connection with the gonadal dysgeneses, the following may be said:

(a) *Bonnevie-Ullrich syndrome* is a complex of abnormalities in infants and young children of either sex. The commonest signs in infants are low posterior hairline, cutis laxa of the neck and peripheral lymphangiectatic oedema of the extremities; and cubitus valgus, short stature and mental retardation of children. It does *not* imply gonadal dysgenesis, although this is a frequent concomitant. The karyotype varies from normal male to normal female. Subjects with this syndrome may develop Turner's syndrome, or, in the male, the Turner phenotype.

(b) *Infantile Turner phenotype* is the name given recently[12] to infant females with the Bonnevie-Ullrich anomaly. It was advocated because so many have gonadal dysgenesis and the 45,X karyotype, which gives a strong, but not positive, indication that Turner's syndrome will develop.

(c) *Female Turner phenotype* describes females with short stature and other Turner-like stigmata but in whom ovarian development and secondary sex features are normal. This is sometimes known as the Ullrich syndrome.[28] The karyotype is that of a normal female; rarely, mosaics have been reported.

The confusion which has appeared in the naming of gonadal dysgenetic syndromes began many years ago when a number of authors applied different names to a series of similar syndromes.[27] Fortunately many of the synonyms have fallen into disuse, while argument still appears in support of, or against, the use of the popularly accepted terminology. For instance, it has been pointed out that infantilism was not obvious to Ullrich when he described a syndrome, because his patient was only 8 years of age; Turner did not realize that similar somatic abnormalities could occur in males.[26] Also, it has been claimed that gonadal dysgenesis is not an obligatory sign of Turner's syndrome because Turner[33] did not make a direct inspection of his patients' gonads. This is sublime when it is considered that Turner described sexual and somatic infantilism and the inability to palpate gonads in any of his 7 patients. It is surprising that Turner did not entertain the possibility of ovarian dysgenesis, which had been demonstrated some time before,[20] but suggested hypopituitary hypogonadism as the cause. However, it was found that patients excreted increased amounts of follicle-stimulating hormone,[34] thus abnegating Turner's theory. Gonadal dysgenesis was finally accepted as the cause of the syndrome following the work of Wilkins and Fleischmann.[35]

Misuse of the eponym, Turner's syndrome, was soon made: the term 'male Turner syndrome' was used[9] to describe a 21-year-old male with certain Turner stigmata. Some authors persist in using the term[28] despite an attempt by Jones *et al.*[23] to clarify and standardize the use of the eponym. They advocated that 'Turner's syndrome' should retain its original meaning and that the designation 'Turner phenotype' should be applied to males or females in whom some features of Turner's syndrome appeared. Thus, 'male Turner phenotype' describes males with Turner stigmata, and 'female Turner phenotype' applies to females with normal ovarian function but sufficient Turner stigmata to raise the possibility of Turner's syndrome as a diagnosis. This logic disposed of the eponym Ullrich's syndrome, which had been used previously.[27] Another suggestion was that the definition of Turner's syndrome had become wider and might include females of short stature with gonadal dysgenesis and somatic abnormalities even if these did not include the cardinal signs.[5] Such subjects should be variants of the syndrome. This practice obviates the need for a separate term to describe individuals without webbing of the neck; they have been called 'ovarian dysgenesis'.[25] Pterygium colli is a variable feature which may be severe or minimal and it is reasonable to assume that subjects without frank webbing represent one end of a continuously varying scale.

The principle of Jones and his colleagues[23] was extended to neonates with the Bonnevie-Ullrich anomaly because many of the females have gonadal dysgenesis and will, with time, evolve the signs of Turner's syndrome. It was therefore recommended that the females be called 'infantile Turner phenotype'.[12] Another school[24] advocated the inclusion of both male and female Turner phenotypes in a new group, Noonan's syndrome. There seems to be little,

if any, advantage in this.

Neonates and infants with the Bonnevie-Ullrich anomaly present a problem of diagnosis. Females (i.e. those with the infantile Turner phenotype) often, but not always, have gonadal dysgenesis but it is impossible to say that they will develop the complete Turner's syndrome.[12] The prediction of Turner's syndrome was facilitated by the advent of nuclear sexing techniques[29] and later, karyotype analysis.[21] Even then the demonstration of the 45,X karyotype in an infant is not conclusive: many abortuses and neonates with this karyotype have had germinal elements in the gonadal streaks and mature subjects have been known to menstruate[21] and even to be fertile.[4] Further indication for caution lies in the knowledge that mosaicism occurs so frequently, and if this is not obvious the appearance of the mature patient may contradict a diagnosis made earlier. However, the presence of an XO cell line does indicate that some, if not all, of the Turner stigmata will later become apparent. It is also interesting that in males the Bonnevie-Ullrich anomaly may give way to the male Turner phenotype (e.g. cases 3 and 4 of Heller[15]).

Pathogenesis

The cause of gonadal dysgenesis has not been established unequivocally. In an endeavour to explain the variable appearance of patients, it was postulated in 1957[19] that 3 closely-linked, deleterious genes controlled short stature, infantilism and somatic abnormalities. This theory was viewed with caution[17] or was rejected[3] because there was no direct evidence to support it. Karyotypic data from patients with gonadal dysgenesis were scrutinized by Ferguson-Smith[8] in an excellent review; he concluded that monosomy of certain genes located on the short arm of the X, or on a small homologous portion of the Y chromosome, was the responsible factor. He further concluded that loss of genes from the long arm of the X might cause gonadal dysgenesis but not Turner's syndrome, as evidenced by patients with the XXq-karyotype. The deletion theory does explain the phenomenon of Turner stigmata appearing in males as well as females[8] and variability of the phenotypes might be explained by the number of loci lost.[26] This in turn recalls the hypothesis of Hoffenberg and Jackson,[19] by which 3 genes controlling infantilism (I), short stature (S) and somatic abnormalities (A) could be inherited singly or in combinations. The possible permutations are as follows:

ISA	gonadal dysgenesis + short stature + abnormalities (Turner's syndrome)
IS	gonadal dysgenesis + short stature (Rössle's syndrome)
IA	gonadal dysgenesis + abnormalities (un-named syndrome; reported[17,21])
SA	short stature + abnormalities (Turner phenotype)
I	gonadal dysgenesis only (pure gonadal dysgenesis)
S	short stature only
A	somatic abnormalities only

It is remarkable that most of these theoretical combinations have been seen clinically. Possibly the *S* and *A* defects, manifested as short stature or somatic abnormalities alone, do occur but have not been recognized as parts of the above series. However, recent evidence[8] indicates the loss of genes, rather than the presence of deleterious genes, as the cause. In the male the ISA combination might be represented by the male Turner phenotype with anorchia, and the SA defect by the more common form in which testes are present but with variable degrees of dysgenesis. Examples of both types were reported by Heller,[15] who also described the condition in an American Negro. To date no Bantu has been reported to have the male Turner phenotype.

This Series

The principal features of the 8 patients reported above are summarized in Table II, and their dermatoglyphic details in Table I.

Case 1 showed the typical infantile Turner phenotype: the Bonnevie-Ullrich anomaly; 45,X karyotype; and, as was shown at postmortem examination, gonadal dysgenesis. It is felt that the appearance of Turner's syndrome in this patient would have been inevitable, one indication of this being the characteristic dermatoglyphs. One previous patient similar to this was mentioned.[23]

Cases 2, 3 and 5 showed the Turner syndrome: they had streak gonads (this is presumed in case 2; the others were inspected directly), short stature and many other Turner stigmata. Webbing of the neck was not severe in cases 2 and 3, and case 5 had no webbing: she should therefore be regarded as a variant of the classic syndrome. Cases 3, 4 and 5 had 45,X/46,XX mosaicism, and illustrate the diversity of the phenotype with similar karyotypes. Case 5, who had a very low percentage of normal cells, was more severely affected than cases 3 and 4, and yet had no webbing of the neck. Also, case 5 was sex-chromatin negative, which demonstrates the variability of that test. An inexplicable feature of case 5 was her dermatoglyphic pattern; this was not 'Turner-like'.

Case 4 had gonadal dysgenesis; she was of normal stature and the only somatic abnormality was a wide chest with pectus excavatum. She is thus classified as belonging to the 'un-named syndrome' (see above). However, this group should probably be included with the pure gonadal dysgenesis group in order to simplify the classification: this is felt to be justified because the general appearance is similar and the somatic abnormalities, when such do occur, are isolated, as Hurwitz[21] noted. Case 8 was regarded as having pure gonadal dysgenesis. It may be argued that because of her slight evidence of secondary sex development, she had ovarian hypoplasia rather than absolute dysgenesis, a point which cannot be contested since her gonads were not biopsied. Nevertheless, in this series she serves as an example of a normally-tall female with normal chromosomes and streak gonads, but no Turner stigmata.

The female Turner phenotype was well illustrated by case 6, who, paradoxically, had more of the Turner stigmata than did cases 2 - 5. There is little doubt that had her daughter (case 7) survived, she too would have shown similar features. Speculation on the mode of inheritance of the Turner phenotype suggested X-linked dominant transmission, although the evidence did not distinguish between this and a submicroscopic deletion.[26] The present patient's family was not available for study. An interesting point concerning the baby (case 7) was that she did not

TABLE II. SUMMARY OF FEATURES SHOWN BY PATIENTS

Case No.	*Karyotype*	*Age*	*Height (cm)*	*Armspan (cm)*	*Ground to pubis (cm)*	*Weight (kg)*	*Low hairline*	*Flat occiput*	*Odd ears*	*Micrognathia*	*Fish mouth*	*Webbed neck*	*Wide chest*	*Pectus excavatum*	*Cubitus valgus*	*Axillary hair*	*Pubic hair*	*Pelvic contour*	*Osteoporosis*	*Buttressed humeri*	*Tibial overgrowth*	*Rat-tooth exostosis*	*Cardiac lesion*	*Streak gonads*	*FSH (MU/day)*	*17-oxysteroids (mg/day)*
1	XO	NB	?	?	?	2·7	+	+	+	−	?	+	+	−	−	?	?	?	−	−	−	−	+	+	?	?
2	XO	36	137	130	74	68	+	+	−	−	−	+	+	+	+	T	T	M	+	+	+	+	−	?	?	?
3	X/XX	22	154	167	82	51	+	−	−	+	+	+	+	−	+	−	+	M	+	−	−	−	−	+	6	4·6
4	X/XX	60	168	177	?	?	−	−	−	−	−	−	+	+	−	−	−	M	+	−	−	−	−	+	?	?
5	X/XX	20	128	138	67	39	+	+	−	+	+	−	+	+	+	−	−	M	+	−	+	+	−	+	?	12·7
6	XX	24	145	149	77	60	+	+	+	+	+	+	+	+	+	−	+	M	+	?	?	?	−	−	?	11·8
7	XX	NB	?	?	?	1·9	+	+	+	−	?	−	+	+	?	?	?	?	?	?	?	?	−	−	?	?
8	XX	25	165	177	?	64	−	−	−	−	−	−	−	−	−	+	+	F	−	−	−	−	−	+	48	10·5

+ = present; − = absent; ? = not examined/reported; T = after oestrogen therapy; M = masculine; F = feminine.

show the Bonnevie-Ullrich anomaly.

Dermatoglyphic Studies

Cases 1, 2, 3 and 5 were regarded as having the Turner syndrome in one or other of its forms, and all except case 5 had dermatoglyphic patterns which corresponded with this view. Other authors have described a high total ridge count (TRC), distal displacement of triradius *t* and a high frequency of simian creases in Turner's syndrome,[7,14] and in X/XX mosaics a more normal TRC.[14] There is no obvious explanation for the low TRC and low a-b count in case 5.

Case 6, with the female Turner phenotype, appears to share the features of the patients reported by Nora and Sinha,[26] who had 'low ridge counts' and distal displacement of *t*. Unfortunately the authors gave no details, so that close comparison between their subjects and case 6 is not possible. The present patient had an exceptionally low TRC, due to the presence of 8 arches. No details of ridge patterns were visible in the hands of her baby daughter (case 7) although the palmar flexion creases were abnormal.

Other Observations

Hormone excretion patterns in patients with gonadal dysgenesis are known to be disturbed,[27] the urinary excretion of FSH being raised, and of 17-oxysteroids reduced. However, some patients may have normal or even lowered FSH excretion, so that the diagnostic value of the test is open to question. Also, variation of techniques at different centres makes comparison of such results difficult.[17] The findings in those of the present patients who were subjected to endocrine assays are shown in Table II; no exceptional results were noted. No patient was found to have any X-linked disorder; routine testing with the Isihara colour vision test charts was unproductive.

A notable omission from many published reports is the lack of information concerning the racial origin of the patient. This is also true of local authors, which is surprising since race is known to have a bearing on the incidence of congenital, and other, diseases in South Africa: it may be that authors were not aware of the interesting inter-racial variations. At present it is not possible to estimate the frequency of gonadal dysgenesis in females of the 4 race groups of Natal: those who have been seen form a highly selected sample, and in any case probably represent only a small proportion of the total number of affected individuals. Of the Bantu patients investigated at this laboratory, females with gonadal dysgenesis form a much larger group than hermaphrodites (9:2 during the past 18 months), which is the reverse of the situation as reported in the Transvaal[25,26] and Rhodesia.[30] Unfortunately there is, at present, no way of ensuring that all patients with defective sex development are studied, since these are not notifiable disorders. Many more observations will have to be made before reliable estimates of incidence and prevalence in the four race groups can be made.

The role of dermatoglyphic analysis in clinical medicine is gradually becoming more widely appreciated and it is hoped that in future more case reports will include the relevant details. However, it is of little benefit to readers when insufficient information is given (as in a report[28] of familial occurrence of the Turner phenotype) or if data from patients with different karyotypes are grouped (for instance, 'Turner's syndrome' in a recent text[30]).

SUMMARY

Four patients with Turner's syndrome, as well as 1 with the infantile Turner phenotype, a mother and daughter with the female Turner phenotype, and 2 with pure gonadal dysgenesis, are reported. All were Bantu of the Zulu nation. Clinical, cytogenetic and dermatoglyphic features of the patients are given. The nomenclature, classification and pathogenesis of gonadal dysgenesis are discussed briefly. The importance of including details of the patient's racial origin and dermatoglyphic profile is emphasized.

I wish to thank the many doctors who have allowed me to examine and report their patients, in particular, Drs A. Tarr and R. Jones of Edendale Hospital, Pietermaritzburg, and Drs M. Parent and A. Vinik of King Edward VIII Hospital, Durban; also Dr Mary Davidson for her help in examining pathological and histological specimens, and Dr M. Notelovitz for his help and advice in preparing the manuscript. I should also like to thank Dr B. G. Grobbelaar, Director of this Institute, for his permission to publish.

REFERENCES

1. Achs, R., Harper, R. G. and Herrick, N. J. (1966): New Engl. J. Med., **275**, 1273.
2. Alter, M. (1966): Medicine (Baltimore), **46**, 35.
3. Ashley, D. J. B. (1962): *Human Intersex*. London: Livingstone.
4. Bahner, F., Schwarz, G., Hienz, H. A. and Walter, K. (1960): Acta Endocr. (Kbh.), **35**, 397.

5. De La Chapelle, A. (1962): *Ibid.*, **40**, suppl. 65.

6. Dinner, M. (1969): S. Afr. J. Surg., **7**, 49.

7. Engel, E. and Forbes, A. P. (1965): Medicine (Baltimore), **44**, 135.

8. Ferguson-Smith, M. A. (1965): J. Med. Genet., **2**, 142.

9. Flavell, G. (1943): Brit. J. Surg., **31**, 150.

10. Forbes, J. L. and Hammar, B. (1966): Arch. Dis. Childh., **41**, 102.

11. Ford, C. E., Jones, K. W., Polani, P. E., De Almeda, J. C. and Briggs, J. H. (1959): Lancet, **1**, 711.

12. Gordon, R. R. and O'Neill, E. M. (1969): Brit. Med. J., **1**, 483.

13. Grace, H. J.: Unpublished data.

14. Guinet, P., Laurent, C. and Robert, M. M. (1968): Rev. lyon. Méd., **17**, 995.

15. Haddad, H. M. and Wilkins, L. (1959): Pediatrics, **23**, 885.

16. Harnden, D. G. and Stewart, J. S. S. (1959): Brit. Med. J., **2**, 1285.

17. Hauser, G. A. *in* Overzier, C., ed. (1963): *Intersexuality*. London: Academic Press.

18. Heller, R. H. (1965): J. Pediat., **66**, 48.

19. Hoffenberg, R. and Jackson, W. P. U. (1957): Brit. Med. J., **1**, 1281.

20. Holt, S. B. (1968): *The Genetics of Dermal Ridges*. Springfield, Ill.: C. C. Thomas.

21. Hurwitz, M. B. (1966): S. Afr. J. Obstet. Gynaec., **4**, 79.

22. Jacobs, P. A., Harnden, D. G., Buckton, K. E., Court-Brown, W. M., King, M. J., McBride, J. A., MacGregor, T. N. and Maclean, N. (1961): Lancet, **1**, 1183.

23. Jones, H. W., Turner, H. H. and Ferguson-Smith, M. A. (1966): Lancet, **1**, 1155.

24. Kaplan, M. S., Opitz, J. M. and Gosset, F. R. 1968): Amer. J. Dis. Child., **116**, 359.

25. Klempman, S. (1964): S. Afr. Med. J., **38**, 234.

26. Nora, J. J. and Sinha, A. K. (1969): Birth Defects: Original Article Series, **5**, 29.

27. Polani, P. E. (1961): Brit. Med. Bull., **17**, 200.

28. *Idem* (1969): Birth Defects: Original Article Series, **5**, 24.

29. Polani, P. E., Hunter, W. F. and Lennox, B. (1954): Lancet, **2**, 120.

30. Rössle, R. and Wallart, J. (1930): *Op. cit.*[37]

31. Singh, R. P. and Carr, D. H. (1966): Anat. Rec., **155**, 369.

32. Swyer, G. I. M. (1955): Brit. Med. J., **2**, 709.

33. Turner, H. H. (1938): Endocrinology, **23**, 566.

34. Varney, R. F., Kenyon, A. T. and Koch, F. C. (1942): J. Clin. Endocr., **2**, 137.

35. Wilkins, L. and Fleischmann, W. (1944): *Ibid.*, **4**, 357.

36. Wilton, E. (1969): S. Afr. J. Surg., **7**, 45.

37. Zander, J. and Henning, H. D. *in* Overzier, C., ed. (1963): *Intersexuality*. London: Academic Press.