DEVELOPMENT AND MORPHOGENESIS OF TESTIS IN HUMAN FETUSES

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ABSTRACT

Development and maturation of prenatal testis was studied on 104 human male fetuses. At 9 weeks, the testes were seen as elongated yellowish tissue superolateral to the developing urinary bladder and medial to mesonephros. The testis assumed ellipsoidal shape at 13 weeks. At about 16 weeks, the testes developed convexity on its anterior aspect. Epididymis and testis were at the same level until 20 weeks thereafter the upper testicular pole was encroached upon by the epididymis, with complete encroachment till its anterior aspect at 24 week. The sinus was also distinctly present between the two. The testis assumed miniature adult testis at term, but its size was approximately 1/15th of the adult. Cytoarchitecture of the testis at 9 weeks revealed radially disposed sex cords. At 13 weeks, tunica albuginea, tubular organization in the parenchyma and the Leydig cells were identifiable. At 17 weeks, tunica vasculosa and incomplete lobules were apparent. At 24 weeks, testis was marked by more but solid seminiferous tubules lined by 4-5 germ layers. Leydig cells were also identifiable till 24 weeks. Spermatogenic cells, both pale and dark type were distinguishable although pale spermatogonia were more numerous than dark cells. 28 weeks onwards tunica vaginalis and complete septa in the testicular parenchyma were evident. Moreover, the seminiferous tubules developed central vacuolation. By 30 weeks, seminiferous tubules became more complex as evident by their increase in number and coiled and tortuousity. At term, the fetal testis had not yet attained the cytoarchitecture of the adult testis suggesting that testicular maturation continues postnatally.

Key Words: Testis, seminiferous tubules, spermatogonia, Sertoli cells, Leydig cell

INTRODUCTION:

The gonads are derived from three different components: the primordial germ cells, the coelomic epithelium and subjacent mesenchyme of the mesonephric ridge (Hamilton and Mossman, 1972)[1]. Gruenwald(1942)[2] noted that the gonads first appeared as a uniform gonadal blastema formed by the coelomic wall with contribution from mesothelium and mesenchyme and the first indication of sex differences appeared as a slightly better limitation and more parallel arrangement of cords in the testis in embryos of 15-17mm (early 7 weeks). According to Wyndham (1943)[3], the testes were represented by a thickening of the germinal epithelium in an embryo of 14mm (6 weeks) and Mc Kay et al (1953)[4] observed that the male gonad was differentiated into testis in 23 mm (late 7 weeks) embryo. Elias (1974)[5] observed that cells in the testis were initially plates rather than cords. Subsequently, the plates were transformed into cylindrical cords which in turn underwent lumen formation and eventually gave rise to the seminiferous tubules.

Mancini et al (1960)[6] observed that fetal testis contained two cellular types: (a) primitive spermatogonium having a rounded nucleus and welldefined cytoplasm and (b) supporting or indifferent cell with a scarcity of cytoplasm, poorly defined limits and an elongated nucleus generally oriented with the longer axis perpendicular to the basement membrane. According to Vilar (1970)[7], the seminiferous epithelium of the newborn human testis comprised of solid cords about 50 μ in diameter where two types of cells were easily differentiated. The first was the precursor of the Sertoli cells, the cuboidal or columnar cells with round or elongated nucleus, often indented, which was predominant and formed a multilayer tissue attached to the basement membrane. The second type belonged to the germinal line, primordial germ cells or the gonocytes, which were large cells having a basophilic cytoplasm and clear nucleoplasm with a characteristic nucleoli, located laterally but occasionally at the centre of the cord. And in the intertubular spaces, different types of cells with special distribution were seen, which

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were designated as type A, B, C and D fibroblast like cells, fetal and adult Leydig cells and degenerating cells, which represented progressive steps in the transformation of the mesenchyme (fibroblast A) to the fetal or adult Leydig cells.

Testicular dysgenesis and maldevelopment have been known to cause undescended testis which is present in approximately 4.5% of males at birth and is associated with various complications most significantly infertility and malignancy (Khatwa and Menon, 2000)[8]. In view of the importance of testicular development and morphogenesis in normal fertility as well as in the pathogenesis of undescended testis, the present study was as taken up to reevaluate and provide a more comprehensive knowledge of development, maturation and histology of the human testis besides the existing knowledge.

MATERIALS AND METHODS:

The materials studied consisted of one hundred and four normal human fresh male fetuses of different gestational ages ranging from 9 weeks (35mm) to 40 weeks (440mm), products of terminated pregnancy under MTP Act of India, 1971 and stillbirths collected from the Department of Obstetrics and Gynecology, RIMS, Imphal with permission from the local ethical committee. Only those fetuses which were free from any gross anatomical abnormality were selected for the present study. The age of the fetuses were calculated from the obstetrical history, crown rump length (CRL) and gross features. The fetuses were preserved in 10% formalin for 10 days and then dissected.

Gross observations regarding the shape, size and weight of the testis and its relation to the epididymis were observed and noted. To study the microstructure, the specimens were fixed in neutral buffered formalin and were subjected to standard histological processing and routine haematoxylin and eosin staining. Slides were examined for general morphology and cellular architecture under different magnifications.

RESULTS:

Gross Observation:

There was a gradual increase in the weight and the size of the testis in all dimensions as age advanced. In 70% of the cases, right testis was heavier than the left (Table I).

In the earliest specimens of 9 weeks, the testes were located on the anteromedial aspect of the developing mesonephros in the lower abdomen at L3-4 level and were recognizable as elongated yellowish strips of tissue with slight depression on their medial side (Fig.2a). At 13 weeks, the testes were found in the groin above the deep inguinal ring (Fig.1a). They assumed the definitive adult ellipsoidal shape with convex curvatures in all aspects except the posterior aspect which was flat and related to the mesonephros, the anlage of the epididymis. At about 16 weeks, the testes were still found above the deep inguinal ring. The anterior border of the testis was replaced rather by a convex anterior aspect whilst its posterior border remained nearly straight and obscured by the epididymis, which was distinctly present as elongated structure by the posterolateral side of the testis and extending towards its lower pole. Simultaneously a slit i.e. anlage of the future sinus appeared between testis and the epididymis along the lower 2/3rd on the posterolateral aspect of the testis (Fig.2b). Till 20 weeks, the head of the epididymis was seen almost at the same level as the upper pole of the testis, from then on, it started encroaching upon the upper pole.

At 24 weeks, the testes were found at a lower level than the preceding age group, just above or at the deep inguinal ring (Fig.1b) or even inside the inguinal canal in one case. The testis was much bigger in size with prominent convexities along its anterior border. Simultaneously, the testicular poles became more prominent and rounded and subserosal microvasculature with coiled blood vessels was visible to the naked eye. At this stage, epididymis became well developed with its adult anatomical identifiable parts i.e. head, body and tail, the largest part being the head which gradually tapered to the body and tail. By this time, the head of the epididymis encroached the whole of the upper pole of the testis extending up to the anterior border while its tail was continuous into vas deferens at the middle part of the posterior border of the testis. The sinus was much deeper and more distinct than before separating the testis from the epididymis almost completely except near its lower pole (Fig.2c) and by 30 weeks, the sinus extended even towards the lower pole of the testis and near that point, the tail of the epididymis was continuous into vas deferens (Fig.2d). Around this time, the testes were found descending with majority of them entering the scrotum. By 36 weeks, the testes were found inside the scrotal sac reaching the bottom of the scrotum (Fig.1d)). There was overall increase in the size of the testis with maximum convexity at the

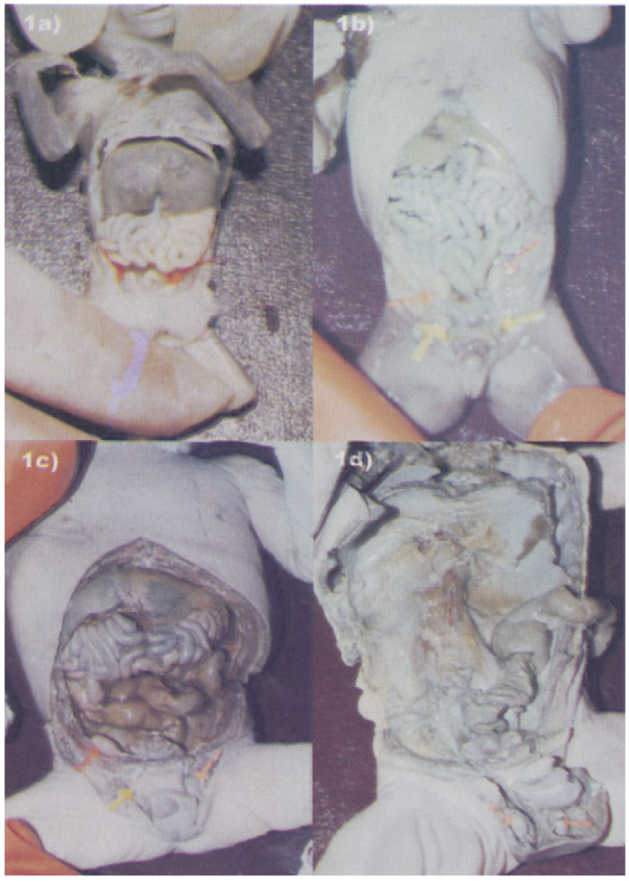

Fig.1 a-d: Photograph of the fetuses showing different position of the testes (orange arrows) at different gestational ages.

a) Both the testes are in the lower abdomen at 13 weeks.
b) Both the testes are in the groin above deep inguinal ring at 24 weeks.
c) Right testis is above the deep and left is below the superficial inguinal rings at 32 weeks.
d) Both the testes are at the bottom of the scrotum at 40 weeks.

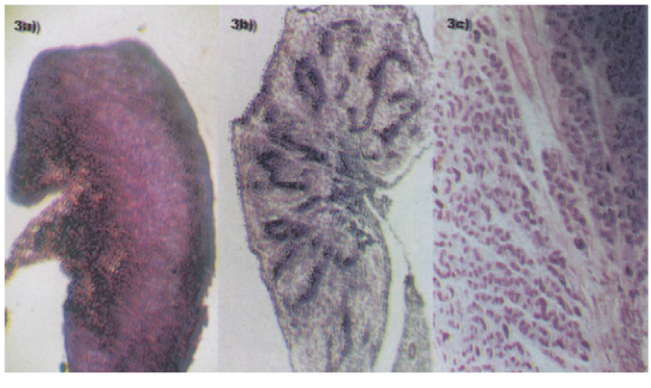

Fig.3 a-c: Photomicrograph showing the cytoarchitecture of the testis. (H/Ex10)

a) At 9 weeks lining germinal epithelium (arrow) and in the parenchyma outer darker zone (1/4th) and inner lighter zone (3/4th) are seen.
b) At 13 weeks, tunica albuginea with posterior thickened mediastinum testis and in the parenchyma horseshoe shaped seminiferous tubules are seen.
c) At 30 weeks, coiled seminiferous tubules are seen.

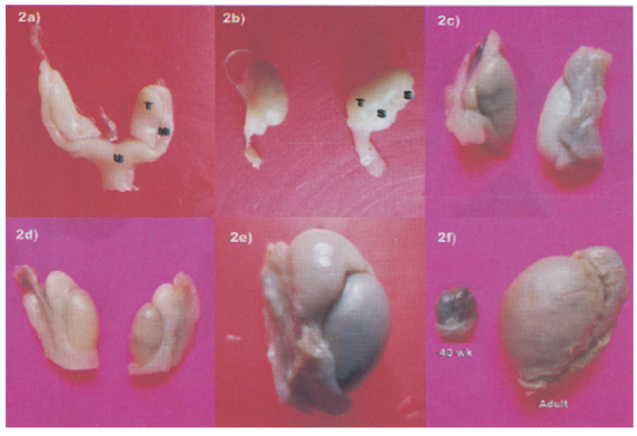

Fig.2 a-f: Photos of the testes at different gestational ages showing their morphogenesis and relation with the epididymis and the sinus.

a) At 9 weeks the elongated testis (T) is superolateral to the urinary bladder (U) and anteromedial to the mesonephros (M)
b) At 16 weeks, the ellipsoidal testis (T) is separated from the epididymis (E) by a slit like sinus (S)
c) At 24 weeks, the upper pole of the testis is completely encroached upon by the epididymis and the they are separated by a distinct sinus except near the testicular lower pole.
d) At 30 weeks, the sinus completely separates the testis and the epididymis.
e) At 36 weeks, the epididymis forms a triangular cap over the testis.
f) At 40 weeks, the epididymis recedes away from the testicular upper pole, where the appendix of the epididymis is seen and the size of the term testis is seen to be only about 1/15th of the adult testis.

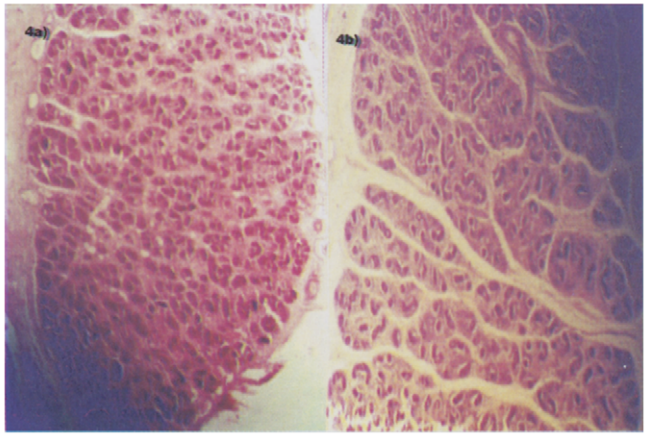

Fig.4 a-b: Photomicrograph showing the testicular lobulation and septae. (H/Ex10)

a) Incomplete septulae testis at 17 weeks.
b) Complete radial septulae testis at 28 weeks.

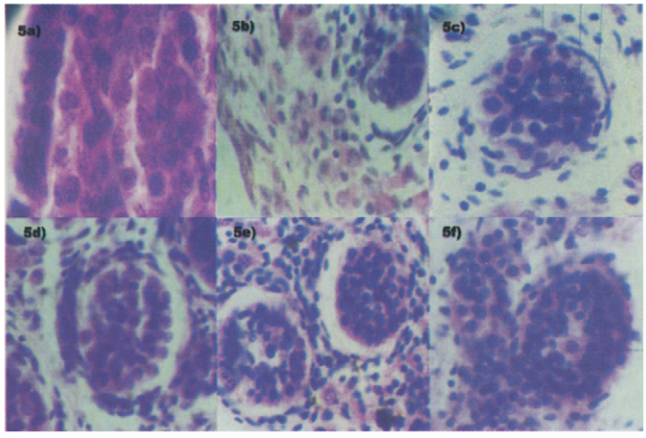

Fig 5 a-f: Photomicrograph of testis showing differentiation and maturation of seminiferous tubules as well as the Leydig cells. (H/Ex100)

a) At 9 weeks, early sex cords are seen lined by both the germ cell and supporting cells with no limiting peritubular mesenchymal layer and are also seen to be continuous at places with the cuboidal and columnar cells of the lining germinal epithelium.
b) At 13 weeks, the seminiferous tubules has 2-3 cellular layers and is limited by a distinct peritubular tissue. Eosinophilic Leydig cells are seen for the first time, predominant between the fibrous tunica albuginea and the tubule.
c) At 17 weeks, the seminiferous tubule has 3-4 cellular layers with a single layer of peritubular tissue.
d) At 24 weeks, the seminiferous tubules are lined by 4-5 cellular layers and limited by multiple layers of peritubular tissue.
e) At 28 weeks, seminiferous tubules develop central vacuolation.
f) At 40 weeks, the seminiferous tubule still has no lumen but only the central vacuolation, occupied by agonocytes. leydig cells also exist singly.

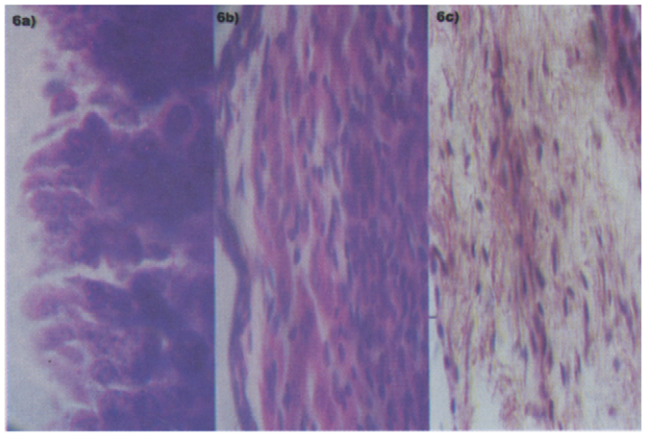

Fig.6 a-c: Photomicrograph showing covering of the testis at different gestational ages. (H/Ex100)

a) Cuboidal to columnar cells of the germinal epithelium limiting the testis at 9 weeks. Continuity of the germinal epithelium with the sex cords is evident.
b) A thin layer of fibrous tunica albuginea forms the testicular limit at 13 weeks. Eosinophilic Leydig cells with spherical vesicular nucleus are prominent deep to the tunic.
c) Cuboidal cells of tunica vaginalis forming the outermost limit of testis at 28 weeks.

Sl. No.	Gestational Age (Wks)	No. of fetuses	Mean Fetal Wt. (gm)	Mean Testicular Wt Right Side (mg)	Mean Testicular Wt Left Side (mg)	Mean Testicular Wt Both sides (mg)
1	9	2	7	5	4.5	4.7
2	10	2	16	8.5	7.5	8
3	11	1	21	14	13	13.5
4	12	2	23.5	15	14.5	14.7
5	13	3	29.3	18	16.8	17.3
6	14	2	43.5	20	19	19.2
7	16	5	70.2	24	25.5	26.5
8	17	4	108.5	28	25.5	26.5
9	18	9	153.9	32	30.6	31.4
10	19	11	212.7	39	37.9	38.6
11	20	8	300.4	56	54.9	55.3
12	21	7	337.1	61	59.4	60.4
13	22	8	356.6	84	81	82.5
14	23	2	480	100	98	98.7
15	24	7	614.1	118	117	117.7
16	25	3	676.3	155	154	155.7
17	26	5	822	179	180	178.8
18	27	3	909.3	195	193	194.2
19	28	4	951.3	241	244	242.5
20	29	2	1465.5	275	273	273.8
21	30	4	1873.8	319	307	313.5
22	32	2	2273	375	349	362.5
23	34	2	2859	477	450	463.5
24	36	2	2925	550	553	551.3
25	38	2	3404.5	780	787	783.5
26	40	2	3604.5	915	910	912.5

Table I: Mean fetal and testicular weight at different gestational ages.

middle of the anterior border and the head of the epididymis was about the same size as that of the testis, covering the whole of its upper pole, encroaching upon its medial and lateral surfaces and looking like a triangular cap of tissue from the side. With further maturation, the tunics of the developing testis and epididymis become well developed and the earlier transparent and translucent tunic revealing the underlying microvasculature was no more seen. The appendix of epididymis was also evident for the first time as a small nodule, between the head of epididymis and the upper pole of the testis (Fig.2e). Beyond 36 week, there was rapid gain in the size of the testis in all dimensions. Comparatively, the growth of the epididymis was much slower especially of its head so that its size was only about 1/5th of that of the testis and moreover, the head of the epididymis receded towards the posterior aspect of the testis. With gradual growth over the rest of the fetal period, the testis assumed miniature adult testis at term, yet its size was approximately 1/15th of the adult (Fig.2f).

HISTOLOGICAL OBSERVATION:

The younger specimens of the testis from 9 to 12 weeks were surrounded by the germinal

epithelium which was composed of very darkly stained columnar or cuboidal cells having an ovoid, vesicular nucleus, oriented perpendicular to the surface (Fig.6a). From13 week onwards, the testis was covered by the fibrous tunica albuginea (Fig.6b) that formed the thickened mediastinum testis posteriorly(Fig. 3b) and deep to it, the tunica vasculosa was visible at 17 week. From 28 weeks onwards, the testis was limited by a capsule made up of an outermost single layer of the tunica vaginalis formed by short cuboidal cells with small basophilic and round to oval nucleus, a middle layer of thick and dense fibrous tunica albuginea and inner thick and loose tunica vasculosa (Fig.6c).

The parenchyma of the testis from 9 to12 weeks was divided into an outer darker zone, which comprised about 1/4th and inner lighter zone, which comprised about 3/4th. The outer zone was invaded by radially disposed cell plates and cords while the inner zone had cellular clumps and loose network forming the rete testis, separated by an appreciable amount of mesenchymal cells and empty looking spaces with the rete converging towards the mesonephros but without any actual connection between the two (Fig.3a). The parallel plates of cells and rounded sex cords in the outer zone were continuous with the germinal epithelium at some areas and were separated by the interstitial tissue that composed of few elongated mesenchymal cells with vesicular nucleus, small rounded mast cells with deeply basophilic nucleus cells and fine fibers. Two major varieties of cells were recognizable in the cords at this stage. One variety was the germ cells or spermatogenic cells which were the large spherical cells with abundant eosinophilic cytoplasm and a clear rounded nucleus with a darkly stained nucleolus. Dark and pale spermatogonia were seen to be differentiated and found interspersed among the few larger gonocytes. The other variety was the supporting or Sertoli cells which were the cells having a scanty perinuclear cytoplasm and elongated vesicular nucleus (Fig.5a).

Subsequently, at the 13 week, early signs of tubular organizations were visible in the testicular parenchyma. The tubules, some in horse shoe shaped sections were seen in the middle 3/5th of the parenchyma arranged at regular intervals, radiating throughout from the rete testis towards the tunica albuginea (Fig.3b). The tubules were solid with no lumen, limited circumferentially by 1-2 overlapping layers of peritubular tissue composed of fine collagen fibers and fibroblastic cells and were lined by spermatogenic cells and supporting cells forming 2-3 cellular layers. Gonocytes along with dark and pale Spermatogonia and were seen. Interstial tissue became prominent with more relative volume than that of the cords. Large eosinophilic polygonal shaped cells, the Leydig cells having spherical vesicular nucleus with fine chromatin threads and a prominent nucleolus were distinct identifiable at this stage and they were predominant in the outer 1/5th of the parenchyma, deep to the tunica albuginea. Some fusiform fibroblastic cells with elongated nucleus, mesenchymal cells, mast cells and fine fibers were also found in the interstial tissue (Fig.5b).

At 17 weeks, strands of connective tissue extended from the deeper aspect of the capsule towards the rete testis as incomplete septulae testis separating the parenchyma into different lobules (Fig.4a). Before 24 weeks, the seminiferous tubules were surrounded by only 1-2 layers of circumferentially arranged fibers and mesenchymal cells of the peritubular connective tissue and were lined by 3-4 layers of cells composed of both spermatogenic and supporting cells. Intertubular stroma had abundant cells with few fine fibers. The predominant cells were still the Leydig cells though many mesenchymal cells and few small mast cells were also present (Fig.5c).

At 24 weeks, testicular development and maturation was marked by more numerous seminiferous tubules. Simultaneously, the peritubular mesenchymal cells increased to 2-3 layers and the lining cells of the tubules to 4-5 layers of cells with better appreciated pale and dark spermatogonia and more peripherally located supporting cells. Interstitial cells of Leydig reduced in number as well as in their size at 24 week concurrently with the reduction in the volume of the interstitial tissue which now consisted of greater amount of fibers, mast cells, mesenchymal cells and fibroblastic cells (Fig.5d). Comparatively, spermatogenic cells were more numerous than the Sertoli cells before 28 weeks and among the spermatogenic cells, pale spermatogonia were more numerous than the dark.

Later at 28 weeks, complete radial septa were seen radiating between the capsule and the mediastinum dividing the testicular parenchyma into many irregular shaped lobules (Fig.4b). At this time, a few seminiferous tubules developed central vacuolation (Fig.5e). 30 weeks onwards, seminiferous tubules became more complex as evident by an

increase in their number and by presence of coiled and tortuous tubules (Fig.3c) As age advanced, the cytoarchitecture of testis became more mature however even in the oldest specimen of 40 weeks i.e. at term; no distinct lumen was present except for central vacuolation which was occupied by spermatogenic cells mostly by the gonocytes (Fig.5f).

DISCUSSION:

Slightly different time of human testicular differentiation had been observed by different workers in this field i.e. at 6 weeks (Wyndham, 1943)[3], early 7 weeks (Gruenwald, 1942)[2] or at late 7 weeks (Mc Kay et al, 1953)[4]. In the earliest specimen of the present study, the testis were already differentiated and the exact time of embryonic stage of testicular differentiation could not be considered as the study was carried out in fetuses only.

Opinions regarding the origin of the cells of the gonads are divergent. Many authors had stated that the sex cords were derived from the proliferating coelomic epithelium (Gruenwald, 1942[2], Hamilton and Mossman, 1972[1], Sadler, 1995[9] and Standring et al, 2005[10]) whereas Satoh (1991)[11] stated that they originated from the mesonephros. The present study agrees with the former authors as it was observed that there was continuity of the sex cords with the coelomic epithelium but continuity of the testis with the mesonephros was only through the mesenchymal tissue not by the sex cords thus reputes the finding of the latter.

By the 4th month, the elongated mass of tissue comprising the embryonic testis had become sufficiently condensed and rounded to assume a form suggestive of its adult shape (Ham, 1969)[12]. The present authors agree with this finding as initially the testes were found as elongated yellowish tissue which assumed ellipsoidal shape at 13 weeks. The finding of a definitive tunica albuginea at 13 weeks in the present study goes against the report of Gruenwald (1942)[2] who highlighted the loss of continuity of the testicular cells and the surface epithelium with the development the tunica albuginea at 7 weeks. In our study, early lobular organization with incomplete septa was seen at 17 weeks and complete septa by 28 weeks. Tunica albuginea progressively thickened during fetal life. These findings support Waters and Trainer (1996)[13] who observed that the tunica albuginea progressively increased in thickness during fetal life and that septa were invariably present beyond 25-28 weeks.

Our study contradicts the finding of Gould and Bernstein (1979)[14] that the fetal testis was organized into solid cords consisting of large clear germ cells and small dense Sertoli cells at 16 weeks as solid cords were observed only at the earlier specimen of 9-12 weeks and thereafter from 13 weeks onwards there was distinct tubular organization. Sadler (1995)[9] mentioned that the early testis cords became horse shoe shaped by 4th month. Similarly in the present work, sparse horse shoe shaped testis cords are observed at 13 weeks in the parenchyma. Young and Heath (2000)[15] observed radially arranged tubular cords without significant coiling at 18 weeks whereas Waters and Trainer (1996)[13] observed that the cords began as straight tubules which became maximally coiled by 30 weeks. The present findings go along with the later as the tubules were straight and radially arranged at 16 weeks and were highly coiled at 30 weeks. In the present study, peritubular mesenchymal cells changed from 1-2 layers to multilayer layers at 24 weeks thus reputes the finding of Gould and Bernstein (1979)[14] that it was 3-5 cells layers at 16 weeks.

Vilar (1970)[7] stated that the seminiferous epithelium of the newborn human testis was composed of solid cords about 50 μ in diameter but Gier and Marion (1970)[16] mentioned that they were 75 μ in diameter and that a few large cells i.e. the primordial germ cell were present in the centre of the cords. Similarly in the present study, initially till 12 weeks, solid cords and then tubules were seen during the fetal period and spermatogenic cells occupied the centre of the tubules even at term (40 weeks). Widely variable opinion is given for the time of lumen formation of the tubules i.e. at 7th month prenatally (Standring et al, 2005)[10], at 6 years (Gier and Marion, 1970[16]) or even at puberty (Larsen, 1997[17]and Sadler, 1995[9]). In the present study, no lumen was present even in the oldest specimen of 40 weeks although vacuolation in the central part of the tubules i.e. future lumen was apparent from 28 weeks onward.

The primordial germ cells were the most striking cells in the seminiferous tubules of new born found laterally but occasionally at the centre of the cords (Vilar, 1970[7]). In the present study, the primordial germ cells or the gonocytes were seen in the sex cords and seminiferous tubules of different age groups. They were also seen to occupy the centre of the cords in the testis of older fetuses (36-40 weeks). According to Vilar (1970)7, the primordial germ cells were transformed into spermatogonia at

2nd month of postnatal life whereas Krause and Cutts (1994)[18] stated that it occurred at 3rd month of development. Mancini et al (1960)[6] mentioned three types of spermatogonia during fetal life: spermatogonia A, E and P and he reported that spermatogonia B developed at puberty only. In the present study, dark and pale spermatogonia were seen in the sex cords and seminiferous tubules. Pale cells were usually more numerous and were found to be located at the basal layer while the dark cells were usually seen at the deeper region.

The Sertoli cells were non-germinal elements which were readily identified within the cell cords formed at the time of testicular differentiation (Gondos, 1977)[19] and the number of the Sertoli cells remained constant from birth (Krause and Cutts, 1994)[18]. In the present work, Sertoli (supporting) cells were observed in all age groups and were distinctly discernable amongst the spermatogenic cells from the earliest specimen of 9 weeks onwards and from 28 weeks they became relatively more numerous than the spermatogenic cells.

Ham (1969)[12] and Gondos (1977)[19] observed that the Leydig cells developed from the interstitial mesenchyme but according to Vilar (1970)[7] they were derived from the fibroblast. In the present study, they appeared initially in a peripheral rim between the tunica albuginea and the sex cords as well as between the cords thus this observation is comparable with that of Gruenwald (1942)[2], Hamilton and Mossman (1972)[1] and Standring et al (2005)[10] that they arose by swelling of the mesenchyme between the sex cords and also from the small peripheral extensions of the primary sex cords. Past authors gave different times of appearance of Leydig cells: at 8th week (Jirasek, 1967)[20], 9th or 10th week (Larsen, 1997)[17] or 12th week (Vilar, 1970)[7]. Our study reputes the above findings as the Leydig cells were observed distinctly for the first time at 13 weeks only. Ham (1969)[12] and Gondos (1977)[19] observed that Leydig cells were particularly abundant between 4th-6th months which was agreed upon by Young and Heath (2000)[15] who further stated that they regressed thereafter only to increase in number during puberty. Gruenwald (1942)[2], Hamilton and Mossman (1972)[1] and Standring et al (2005)[10] stated that they showed marked activity in fetal life especially in 3rd-5th month. Whereas Waters and Trainer (1996)[13] noted that they were most numerous between 17 and 19 weeks and declined thereafter. Gillman (1948)[21] reported that spindle-shaped cells composed the intertubular tissue in young embryos and at 9 weeks, the bulk of the testis was made up of greatly enlarged interstitial cells which reached their peak of development at 18 weeks and declined at 29 weeks. In the present study also, spindle shaped cells filled the spaces between the cords in the younger fetuses but the eosinophilic Leydig cells appeared at 13 weeks, and were predominant in the interstial tissue before 24 weeks. The present workers supports the observations of Vilar (1970)[7] and Waters and Trainer (1996)[13] that they were infrequent but were still present at term and also of Sniffen (1950)[22] that they were quite small and few in numbers at birth.

CONCLUSION:

The testes were distinctly identifiable to the naked eye as an elongated yellowish mass of tissue in the lower abdomen at L3-4 level in the earliest specimen of the present series i.e. 9 weeks gestational age. They assumed the definitive ellipsoidal shape by 13 weeks. There was gradual increase in the size as well as the weight of the testis as age advances. Right testis was usually heavier than the left (70%). The size and weight of the testis at 40 weeks (full term) was about 1/15th of that of the adult.

Histologically, the testis was initially enclosed by the germinal epithelium and then by tunica albuginea from 13 weeks up to 28 weeks when tunica vaginalis developed external to it. Tunica vasculosa developed by 17 weeks deep to tunica albuginea. Incomplete septulae testis appeared by 17 weeks and became complete by 28 weeks. Seminiferous tubules were horse shoe shaped and uncoiled and became highly coiled by 30 weeks. They were encircled by 1-2 layers of peritubular mesenchymal cells till 24 weeks and by 2-3 layers beyond that. They were solid without any lumen in all the cases though central vacuolation appeared by 28 weeks. Tubules were lined by two morphological distinct cell types: the supporting cells (pre-Sertoli cells) and spermatogenic cells. Pale spermatogonia were usually more numerous than the dark cells. Leydig cells were the most striking and most numerous in the interstitial tissue till 24 weeks.

The detailed knowledge of the developmental anatomy of the testis will help the clinicians to deal better with the problems related to the testis.

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