

Incidence and structure of the appendices of the testis and epididymis

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(Accepted 28 May 1996)

ABSTRACT

In paired testes obtained from 425 adults, 50 children and 10 neonates, the incidence of testicular appendices was 76% in adults (93.3% sessile) and 83.3% in neonates/children (88% sessile). An epididymal appendix was present in 21.9% of adults and 20% of neonates/children, out of which 79% were stalked in both types of specimen. Three sessile testicular appendices and 11 epididymal appendices were double. The microscopic structure of the appendices and the ultrastructure of their epithelia are described. Testicular or epididymal appendices were not present in any domestic or laboratory animal examined except the horse.

Key words: Hydatids of Morgagni.

INTRODUCTION

In autopsy material, Morgagni (1761) located a 'hydatid' at the globus major of the epididymis and a small fimbria at the upper end of the testis. His book was translated into English by Alexander (1769). Since then the 2 appendages have been called 'hydatids of Morgagni'. The appendix of the testis is described as a small sessile globular structure located at the upper pole of the testis just below the head of the epididymis and is considered to be a remnant of the cephalic end of the paramesonephric duct. The epididymal appendix is frequently stalked and is present on the head of the epididymis; it possibly represents the cranial blind end of the mesonephric duct. Information regarding the frequencies of these appendices and their structure is scanty. As the 2 structures are small and vestigial, little attention was paid to them in the past, but in recent years paediatric surgeons and urologists have shown considerable interest in them as cases of torsion have been reported (Ambrose & Skandalakis, 1957; Jones, 1962; Skoglund et al. 1970; Altaffer & Steele, 1980; Krukowski & Auld, 1983) and a case of cystadenocarcinoma of the testicular appendix has been recorded (Kernohan et al. 1990). The present paper

documents the incidence of the 2 types of appendage in northwest Indian subjects. Their microscopic and ultrastructural appearance is also described.

MATERIALS AND METHODS

The material for the present study consisted of paired testes obtained from 425 adults (aged 18–80 y) and 50 children (1–17 y) on whom medicolegal autopsies had been conducted by the 2nd author during the years 1980–1992. The subjects were residents of the Chandigarh region of northwest India. Paired testes were also obtained from 10 neonates. All specimens appeared to be normal macroscopically. Testes were divided according to various age groups as given in Table 1. The dimensions of the appendices were measured to the nearest 0.01 mm by a sliding calliper with a vernier attachment (Mitutoyo). For the neonates, the appendices were measured using a large magnifying lens (Magnavision).

Ten specimens each of sessile and stalked testicular appendices and of stalked epididymal appendices (2 neonates, 2 children and 6 adults of each type) and 4 specimens of sessile epididymal appendices (1 neonate, 1 child, 2 adults) were separated from the testes and epididymis; after processing, serial 10 µm sections

Table 1. Dimensions of sessile appendices of testes (mm)

Age group	N (paired testes examined)	N (appendix present right side)		Dimensions (mm) (mean \pm S.D.)	N (appendix present left side)	Dimensions (mm) (mean \pm S.D.)	t value*
Neonates	10	8 (80%)	Length	1.67 \pm 0.70	7 (70%)	1.26 \pm 0.49	1.32
			Breadth	1.23 \pm 0.25		1.45 \pm 1.04	0.50
			Thickness	0.30 \pm 0.25		0.46 \pm 0.11	0.06
1-14 y	35	25 (71.43%)	Length	2.30 \pm 1.74	27 (77.14%)	2.00 \pm 1.34	0.75
			Breadth	1.33 \pm 1.18		1.57 \pm 1.00	0.22
			Thickness	0.37 \pm 0.19		0.55 \pm 0.18	0.07
15-17 y	15	11 (73.33%)	Length	3.20 \pm 1.26	10 (66.67%)	2.90 \pm 1.39	0.21
			Breadth	2.30 \pm 0.84		2.00 \pm 0.91	0.81
			Thickness	0.60 \pm 0.21		0.60 \pm 0.13	0.00
18-20 y	33	23 (69.70%)	Length	4.10 \pm 2.10	24 (72.73%)	4.00 \pm 2.00	0.35
			Breadth	3.40 \pm 1.60		3.30 \pm 1.50	0.23
			Thickness	0.50 \pm 0.40		0.50 \pm 0.50	0.00
21-30 y	168	120 (71.43%)	Length	4.30 \pm 2.30	116 (69.05%)	4.20 \pm 2.30	0.43
			Breadth	3.60 \pm 1.80		3.50 \pm 1.80	0.55
			Thickness	0.60 \pm 0.30		0.60 \pm 0.30	0.00
31-40 y	77	58 (75.32%)	Length	4.50 \pm 1.40	59 (76.62%)	4.40 \pm 2.40	0.29
			Breadth	3.80 \pm 1.90		3.60 \pm 1.90	0.86
			Thickness	0.70 \pm 0.40		0.60 \pm 0.40	1.66
41-50 y	66	48 (72.73%)	Length	4.60 \pm 2.50	47 (71.21%)	4.50 \pm 2.50	0.40
			Breadth	3.90 \pm 2.00		3.80 \pm 1.90	0.26
			Thickness	0.90 \pm 0.50		0.80 \pm 0.30	0.83
51-60 y	43	34 (79.07%)	Length	3.50 \pm 2.10	31 (72.09%)	3.40 \pm 2.20	0.41
			Breadth	2.80 \pm 1.70		2.90 \pm 1.80	0.10
			Thickness	0.70 \pm 0.30		0.60 \pm 0.40	0.71
Above 60 y	38	22 (57.89%)	Length	3.00 \pm 1.90	21 (55.26%)	3.20 \pm 2.10	1.73
			Breadth	2.70 \pm 1.40		2.70 \pm 1.60	0.00
			Thickness	0.70 \pm 0.40		0.60 \pm 0.30	0.33
Total	485	349			342		

Stalked testicular appendices are not included in the Table.

* All nonsignificant; $P > 0.05$.

were cut and stained with haematoxylin and eosin and Masson's trichrome. Five sessile appendices from adult testes and another 5 stalked appendices from adult epididymes were fixed in glutaraldehyde and osmium tetroxide, and embedded in Epon. A few sections from each block were cut at 0.5-1.0 μ m and stained with toluidine blue. After selecting the area, ultrathin sections were cut at 60 nm and stained with uranyl acetate and lead citrate for electron microscopy. In addition, paired testes from the following domestic and laboratory animals, 5 for each species, were examined for the presence of appendices: dog (*Canis domesticus*), pig (*Sus scrofa*), goat (*Capra hircus*), sheep (*Ovis aries*), rabbit (*Oryctolagus cunicullus*), rat (*Rattus rattus*), mouse (*Mus mus*) and guinea pig (*Cavia porcellus*). A pair of testes from a horse (*Equus domesticus*) were also examined.

RESULTS

The incidence of testicular and epididymal appendices in the adults and neonates/children, and whether they were sessile or stalked, is shown in Tables 2 and 3. In

adults, testicular appendices were observed in 646 (76%) instances. They were present bilaterally in 250 pairs and unilaterally in 146 pairs. Of the 646 testes possessing an appendix, it was sessile in 603 (93.3%) and stalked only in 43 (6.7%). Three specimens had a double appendix on the right side (Fig. 1); there was no instance of a double appendix on the left. Calcification of the structure was not seen in any specimen.

In adults, an epididymal appendix was identified in 186 (21.9%) instances. It was present bilaterally in 33 pairs of testes and unilaterally in 120 pairs. Out of 186 specimens showing an appendix, it was stalked in 146 (78.5%) and sessile in the remaining 40 (21.5%). Stalked epididymal appendices were double in 8 instances on the right and in 3 on the left. In another right-sided testis, there were 3 stalked epididymal appendices; 2 of the stalks were short, the third being long (Fig. 2). A bilobed stalked epididymal appendix was observed on 1 left testis (Fig. 3). Multiple appendices were not seen bilaterally.

Differences in the incidences of testicular appendices in the adults and neonates/children were not

Table 2. Incidence of testicular and epididymal appendices in adults*

Side involved	Testicular (present in 646—76%)				Epididymal (present in 186—21.9%)			
	Sessile		Stalked		Sessile		Stalked	
	Right	Left	Right	Left	Right	Left	Right	Left
Bilateral	214 (33.1%)	214 (33.1%)	3 (0.5%)	3 (0.5%)	—	—	28 (15.1%)	28 (15.1%)
Sessile on one side and stalked on the other	18 (2.8%)	15 (2.3%)	15 (2.3%)	18 (2.8%)	5 (2.7%)	—	—	5 (2.7%)
Unilateral	73 (11.3%)	69 (10.7%)	—	4 (0.6%)	22 (11.8%)	13 (7.0%)	40 (21.5%)	45 (24.2%)
Total	305 (47.2%)	298 (46.1%)	18 (2.8%)	25 (3.9%)	27 (14.5%)	13 (7.0%)	68 (36.6%)	78 (41.9%)

* n, 425 pairs of testes.

Table 3. Incidence of testicular and epididymal appendices in neonates/children*

Side involved	Testicular (present in 100—83.31%)				Epididymal (present in 24—20%)			
	Sessile		Stalked		Sessile		Stalked	
	Right	Left	Right	Left	Right	Left	Right	Left
Bilateral	31 (31%)	31 (31%)	1 (1%)	1 (1%)	—	—	3 (12.5%)	3 (12.5%)
Sessile on one side and stalked on the other	3 (3%)	4 (4%)	4 (4%)	3 (3%)	—	—	—	—
Unilateral	10 (10%)	9 (9%)	1 (1%)	2 (2%)	3 (12.5%)	2 (8.3%)	6 (25%)	7 (29.2%)
Total	44 (44%)	44 (44%)	6 (6%)	6 (6%)	3 (12.5%)	2 (8.3%)	9 (37.5%)	10 (41.7%)

* n, 60 pairs.

statistically significant ($P > 0.05$); this was also true for the epididymal appendices ($P > 0.05$).

There were 3 specimens with epididymal appendices without an appendix on the testis (Fig. 4). A bilobed or trilobed testicular appendix was not encountered in any specimen.

As shown in Table 1, with advancing age the dimensions of the sessile testicular appendices increased steadily up to 50 y, but declined thereafter. No significant differences between sides in these measurements were detected ($P > 0.05$; Student's *t* test). The breadth and thickness of stalked testicular appendices were similar to those of sessile appendices, but because of the presence of the stalks, their length was on average about 0.5 mm greater. In 1 unusual case, the stalked epididymal appendix in a 21-y-old subject was 11 mm long. The measurements of the stalked and sessile epididymal appendices were almost the same as those of testicular appendices.

Appendices in laboratory and domestic animals

An examination of the paired testes of 8 species of domestic animals, including the dog and pig, did not reveal testicular or epididymal appendices. However, an examination of the paired testes of a horse showed a sessile appendix ($7 \times 5 \times 2$ mm) on the right, located below the head of the epididymis. No epididymal appendix was present on the right nor were there appendices on the left testis.

Structure of appendices

Light microscopy. The stroma of the sessile testicular appendices consisted of loose connective tissue containing a large number of blood vessels, fibroblasts, a few dilated lymphatic vessels and occasional lymphocytes. Sessile testicular appendices from both neonates, 1 child and 1 adult, and stalked testicular appendices from 1 neonate and 1 adult showed

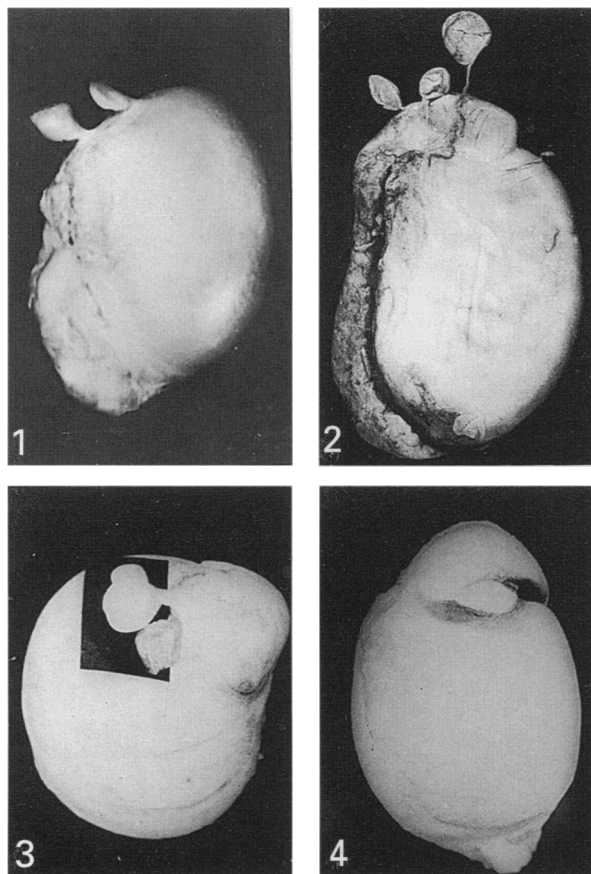


Fig. 1. Right testis showing a double testicular appendix. Natural size.

Fig. 2. Right testis showing 3 epididymal appendices, 2 having short stalks and the third a long stalk. Natural size.

Fig. 3. A bilobed stalked appendix on the left epididymis; a sessile testicular appendix is also seen. Natural size.

Fig. 4. Right testis showing an epididymal appendix without a testicular appendix. Natural size.

varying numbers of acini in the stroma; the acini were lined by nonciliated columnar epithelium (Fig. 5). Serial sections of the appendices showed that these acini differed from invaginated surface epithelium. The collagen fibres just beneath the surface epithelium were somewhat more dense than in the core. A layer of pseudostratified columnar epithelium covering the outer surface which in semithin resin sections possessed 3 layers of cells, basal, intermediate and superficial. The outermost layer, at irregular intervals, showed dome-shaped projections with tufts of cilia (Fig. 6). Stalked testicular appendices had a similar structure, the stalk consisting of collagen fibres, blood vessels and lymphatic vessels and was covered on the outer surface by flattened mesothelium.

The stalked or sessile epididymal appendices were seen to be vesicular structures attached to the epididymis. They contained clear fluid. The cavity of

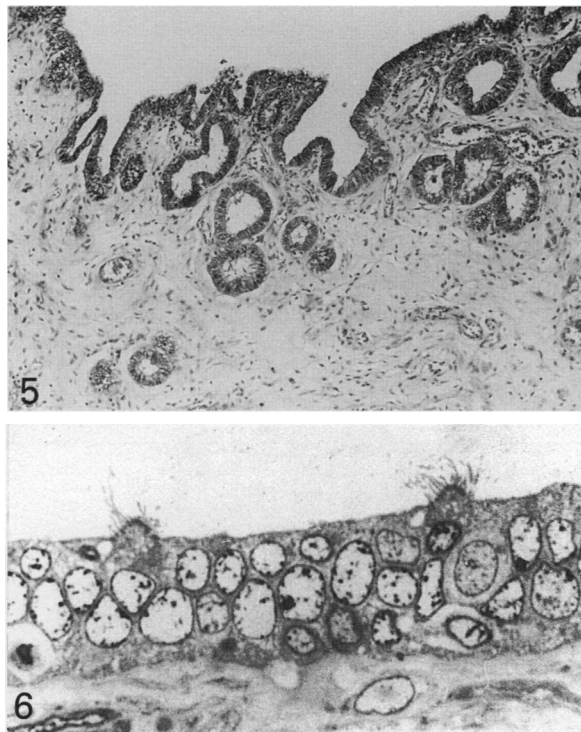


Fig. 5. Section through a testicular appendix showing a loose connective tissue stroma with blood vessels, dilated lymphatics and a few acini. The structure is covered by pseudostratified columnar epithelium. $\times 144$.

Fig. 6. Semithin resin section showing the surface epithelium of a testicular appendix. The epithelium possesses basal, intermediate and superficial layers. Some of the basal cells have abundant pale cytoplasm and most of the cells in the intermediate layer have moderate amounts. The nuclei are large and vesicular with inconspicuous nucleoli. The outermost layer shows ciliated dome-shaped projections at irregular intervals. Toluidine blue, $\times 1400$.

the vesicle was lined by pseudostratified, ciliated columnar epithelium resting on a basement membrane. External to the epithelium was a layer of dense collagen surrounded by loose vascularised connective tissue. The outer surface was covered by flattened mesothelium (Figs 7, 8). The stalk had a structure similar to that of the stalk of the testicular appendices. It was not canalised in any specimen.

Ultrastructure of epithelial cells. In the testicular appendices, the basal cells had prominent hemidesmosomes along the basement membrane. The nuclei of the cells were vesicular and stippled with fine chromatin (Fig. 9). There was abundant electron-lucent cytoplasm with sparse organelles. The intermediate cell had a vesicular nucleus with a small nucleolus. The cytoplasm was moderate in extent and showed vesicular endoplasmic reticulum and many mitochondria. Desmosomal junctions with adjoining cells were also present (Fig. 10).

The superficial cell layer showed, at irregular

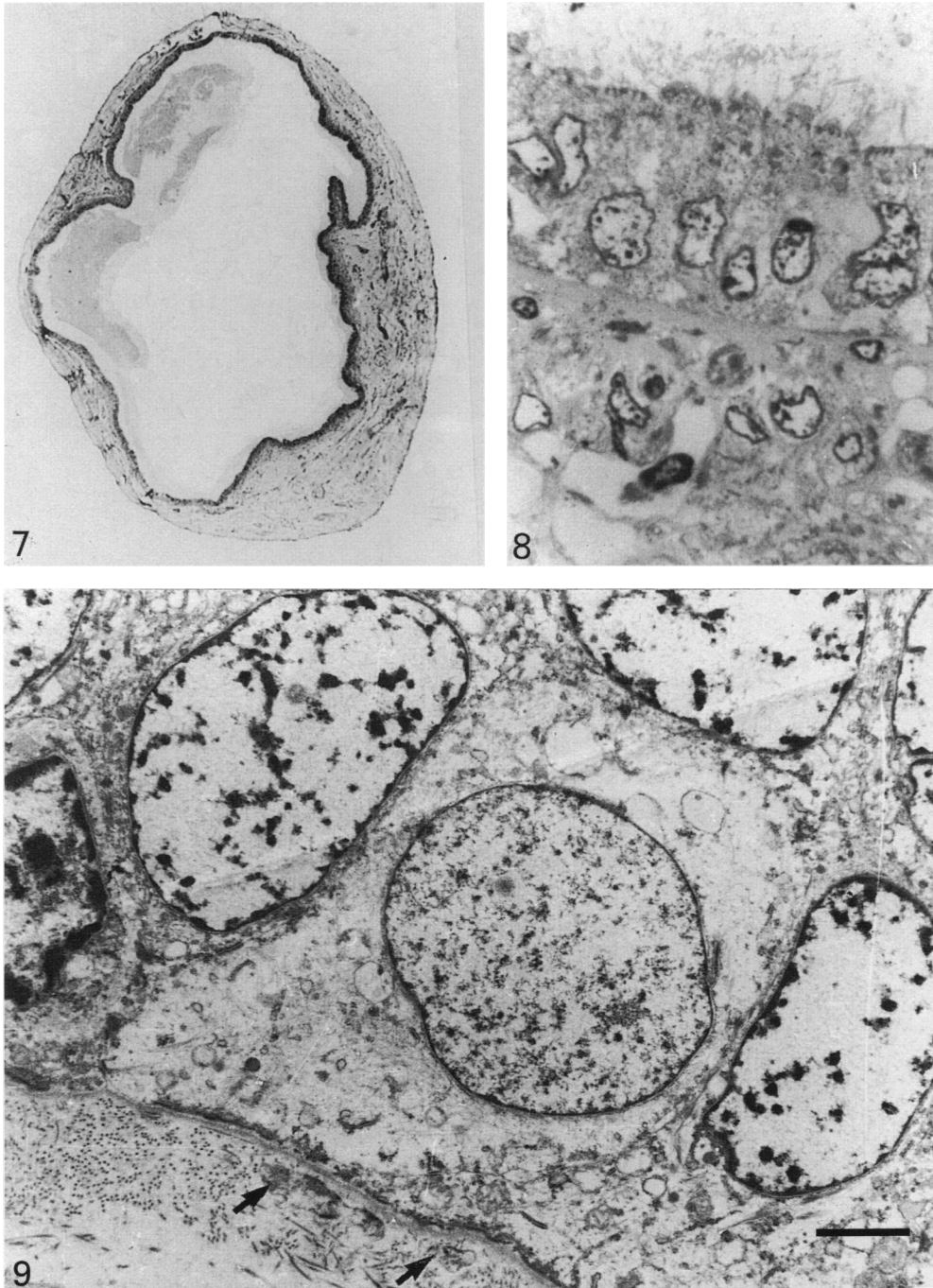


Fig. 7. Section of an epididymal appendix. Its cavity is lined by columnar epithelium, external to which is a layer of dense connective tissue covered on the outer side by flattened mesothelium. $\times 55$.

Fig. 8. Higher magnification of the pseudostratified columnar epithelium lining the cavity of the vesicle of an epididymal appendix. As the nuclei are placed at varying heights in the cells the epithelium is pseudostratified. Almost all cells reaching the lumen are ciliated. Toluidine blue. $\times 1400$.

Fig. 9. Electron micrograph of epithelium of a testicular appendix. The cell in the centre is a basal cell resting on the basement membrane along which it displays prominent hemidesmosomes (arrows). The nucleus is vesicular and is stippled with fine chromatin. There is abundant electron-lucent cytoplasm with comparatively sparse cell organelles. $\times 7000$.

intervals, dome-shaped cells with prominent cilia; these were true cilia with the typical structure of 9 peripheral and 2 central tubules (Fig. 11).

In the epididymal appendices, pseudostratified columnar epithelium lined the cavity of the vesicle.

All cells reaching the cavity were ciliated and had prominent mucin vacuoles along with abundant mitochondria and rough endoplasmic reticulum. These cells showed true cilia as well as microvilli or stereocilia (Fig. 12).

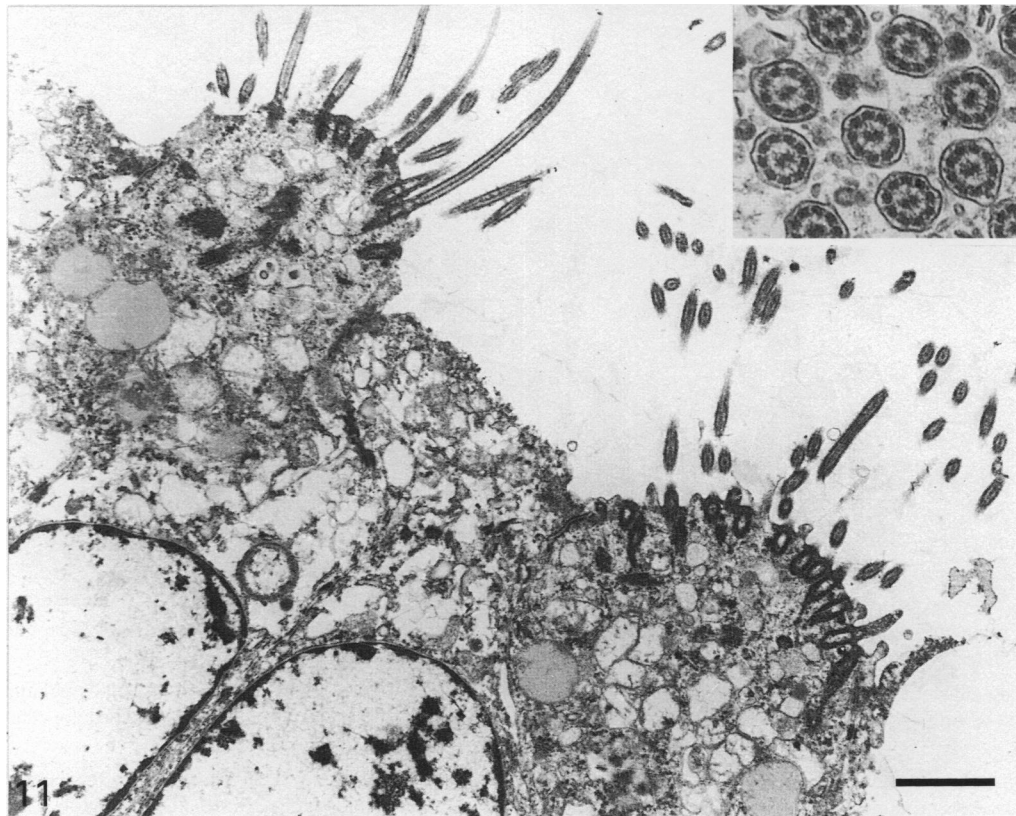
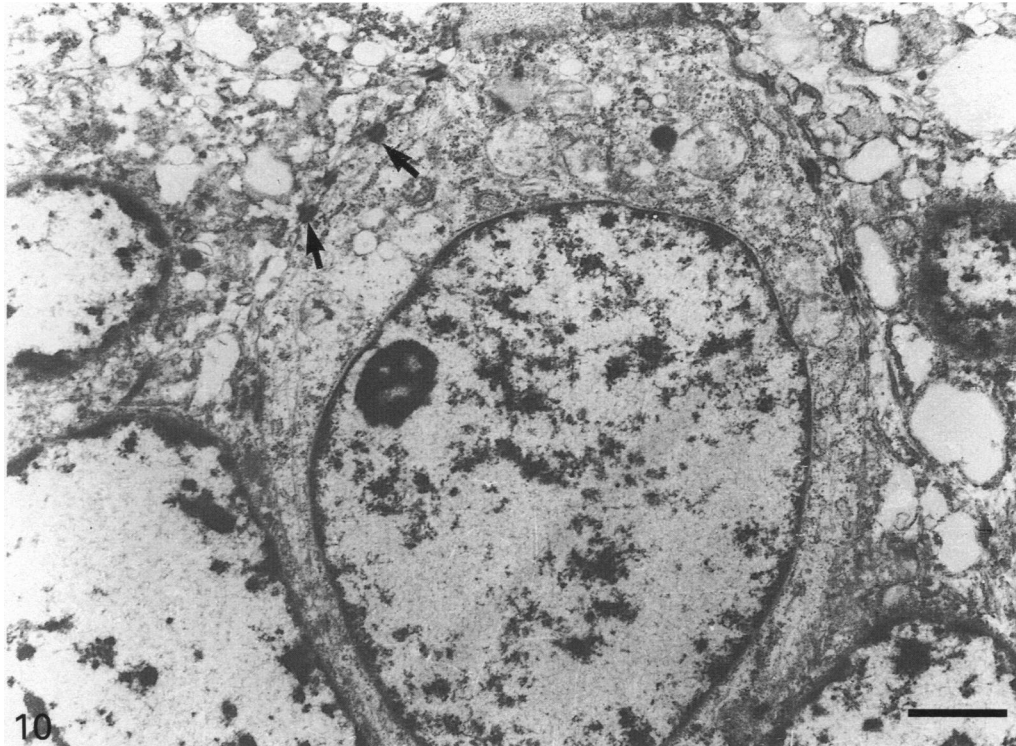


Fig. 10. Electron micrograph of an intermediate cell of the covering epithelium of a testicular appendix. The nucleus is vesicular with a small nucleolus. Vesicular endoplasmic reticulum and many mitochondria are seen; desmosomal junctions (arrows) with adjoining cells are present. $\times 12000$.

Fig. 11. Electron micrograph of the outermost layer of the surface epithelium of a testicular appendix showing ciliated cells containing prominent mucin vacuoles, abundant mitochondria and rough endoplasmic reticulum. The inset gives a transverse section of the cilia, with 9 peripheral and 2 central tubules. $\times 7000$.

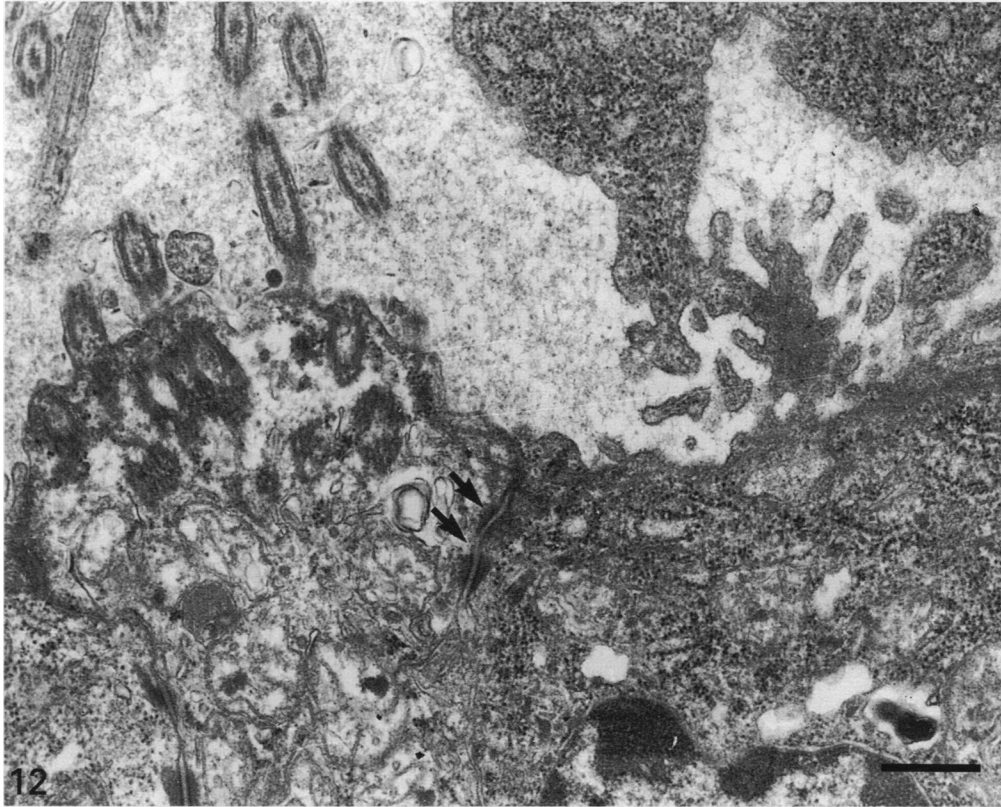


Fig. 12. Electron micrograph of 2 adjoining cells lining the innermost layer of the wall of an epididymal appendix. The cell on the right shows a tuft of microvilli or stereocilia, that on the left possessing true cilia. Desmosomal junctions between the 2 cells are arrowed. $\times 7000$.

DISCUSSION

Morgagni (1761) made no distinction between a hydatid epididymal appendix and a testicular appendix as he considered the latter to be a ruptured hydatid. Griffiths (1893) described the 2 appendices as separate entities, both grossly and histologically. Luschka (1854) found the appendices of the testis to be mostly sessile and those of the epididymis to be invariably pedunculated. Vermeulen & Hagerty (1945) observed testicular appendices in two-thirds of 28 testes examined; in half of these the appendix had a pedicle which could undergo torsion. Rolnick et al. (1968) recorded a still higher incidence (82%) of pedunculated testicular appendices in 100 autopsy cases. In the present material a stalked testicular appendix was present only in 6.7% of the specimens having an appendix; this confirms the observations of some earlier workers (e.g. Watson, 1902). On examining 153 testes, Sundarasivarao (1953) found the incidence of testicular appendices to be 80.20% while that for epididymal appendices was 23.02%. His findings match ours. Griffiths (1893) stated that an epididymal appendix was present only occasionally in early life but was almost always present in adults

above the age of 40 y. Our results show that there is no statistical difference in the incidence of epididymal appendices between the neonates/children and adults.

Apparently multiple testicular or epididymal appendices in a specimen are uncommon. Shattock (1922) reported the case of a 14-y-old boy in whom the right testis had 2 pedunculated testicular hydatids, both of which had undergone torsion. In testes from 100 autopsies, Rolnick et al. (1968) observed a double testicular appendix in 2 specimens and 2-4 pedunculated epididymal appendices in 8 instances. In the present series there were 3 specimens having a double testicular appendix and 11 testes had a double epididymal appendix; in another instance there were 3 stalked epididymal appendices. Surprisingly, double or multiple epididymal appendices were not encountered bilaterally.

According to Griffiths (1893) the stroma of the testicular appendix consists of highly vascularised connective tissue containing an occasional tube-like structure; he was of the opinion that as the surface of the appendix was corrugated, the ingrowing grooves gave the appearance of a tubule in sections. Zuckerman & Krohn (1937) found a tubule in the stroma of testicular appendices in many instances.

According to them the tubule was a remnant of the müllerian duct. This view was also supported by Sundarasivarao (1953). In the present study serial sections of the testicular appendix revealed acini in the stroma in 4 out of 8 (50%) specimens obtained from neonates/children and only in 2 out of 12 (16.8%) adult specimens.

The surface epithelium of the testicular appendix has been described as simple columnar (Watson, 1902) or ciliated columnar (Zuckerman & Krohn, 1937). However, we found the outer surface of the testicular appendix to be covered by pseudo-stratified columnar epithelium. According to Griffiths (1893) the wall of the vesicular epididymal appendix consists of a single layer of nonciliated columnar cells resting on a layer of spindle-shaped cells resembling plain muscle fibres along with connective tissue. Subsequent workers including Watson (1902), Zuckerman & Krohn (1937) and Sundarasivarao (1953) described a similar structure. In the present study the cavity of the vesicle was found to be lined by pseudostratified ciliated columnar epithelium resting on a basement membrane. The stalk of the appendix was not canalised.

When describing the structure of a cystadenocarcinoma of the testicular appendix, Kernohan et al. (1990) included a photograph showing the ultra-structure of the epithelium of a normal testicular appendix; they observed columnar cells on the surface, some of which had true cilia. Our results revealed the presence of true cilia only on dome-shaped cells placed at irregular intervals in the outermost layer of the surface epithelium.

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