ACTA VET. BRNO 2001, 70: 3–7

VASCULATURE OF TESTIS, EPIDIDYMIS AND DUCTUS DEFERENS OF RABBIT. THE ARTERIES

V. RAJTOVÁ, J. DANKO

Department of Anatomy and Histology, University of Veterinary Medicine,
Košice, Slovak Republic

Received October 3, 2000
Accepted February 7, 2001

Abstract

Rajtová V., J. Danko: *Vasculature of testis, epididymis and ductus deferens of Rabbit. The Arteries*. Acta Vet. Brno 2001, 70: 3-7.

The vasculature of the *testis*, *epididymis* and *ductus deferens* was studied in twenty adult rabbits using X-ray apparatus. For filling the roentgen-contrast and also colour-contrast mass we used red lead in 10 % warm gelatin. We found an irregular origin of the bilateral *aa. testiculares* from the aorta. The testicular artery forms, after its *pars recta*, the *pars convoluta* with 13-20 loose loops inside the entire inguinal canal. It enters the parenchyma, then encircles the testis twice under the *tunica albuginea*. The *r. rete testis* is one of the intratesticular branches, which passes through the *mediastinum testis*. The *rr. interlobulares* originate from the *r. rete testis*. The epididymis is supplied by *rr. epididymales* (*cranialis, media* and *caudalis*) and the *a. epididymalis caudalis.* The spermatic duct is vascularized by the *a. ductus deferentis* originating from the *common trunk* of the *a. iliaca externa*. The cremaster muscle supplies the branches of the *a. cremasterica* and *r. cremastericus* from the *a. ductus deferentis*. Several intratesticular anastomoses were found between the parenchymal part of the *a. testicularis* and the *rr. epididymales* and also the *a. epididymalis caudalis.* Our study complets the arterial vasculature of the testis, epididymis and ductus deferens of rabbit.

Arteries, testis, epididymis, spermatic duct, rabbit

Laboratory animals have been, but also will be, appropriate subjects for those experiments that cannot be carried out *in vitro*. Some attention has already been paid by several authors to the structure of their bodies and organ systems (McLaughlin 1972; Barone et al. 1973; Cooper and Schiller 1975; Hebel and Stromberg 1976; Smallwood 1992; Popesko et al. 1992) but many details have not yet been studied.

The study of anatomy, including the vasculature of the testis in domestic mammals, is closely connected with their reproduction. Similarly, in laboratory animals such study is necessary for experiments which, to a greater or lesser degree, provide knowledge which could be applied not only to domestic mammals, but also to man. Examples include the study of the effect of heavy metals on the testicular parenchyma, the effect of ionizing radiation, the effect of some medicaments, disorders in the circulation of the blood, as well as various experimental surgical interventions.

Among laboratory animals, perhaps the vascularization of the rat testis has been studied the most (Harrison 1949; Harrison and Weiner 1949; Kormano 1967; Vrzgulová and Hajovská 1968; Hebel and Stromberg 1976; Chubb and Desjardins 1982; Melman et al. 1985). This problem has been studied, to a much lesser degree, in the mouse (Harrison 1949; Harrison and Weiner 1949; Froud 1959; Suzuki 1982; Chubb and Desjardins 1982), the guinea pig (Cooper and Schiller 1975), the golden hamster (Michel 1959) and in the rabbit (Harrison 1949; Harrison and Weiner 1949; Chubb and Desjardins 1982).

The purpose of the present work is to study the arterial supply and its sources in the male rabbit's genital gland, epididymis, scrotum and the *ductus deferens*.

Address for correspondence:
Prof. MVDr. Viera Rajtová, DrSc.
Department of Anatomy and Histology
University of Veterinary Medicine
Komenského 73, 041 81 Košice, Slovak Republic

Phone: +421 95 633 8192
Fax: +421 95 632 3666
E-mail: rajtova@uvm.sk
http://www.vfu.cz/acta-vet/actavet.htm

Materials and Methods

For the study, twenty healthy male rabbits weighing 2.5-3 kg from private breeders were used. The animals were euthanized by prolonged anaesthesia administered as an inhalant using either chloroform or ether. Immediately following euthanasia, the vascular network was perfused by a physiological solution with the addition of Heparin (Léčiva) at the dose of 1 ml (5000 U. I.) per 250 ml of solution, through the *left cardiac ventricle*. During the injection, the *v. cava cranialis* was opened in order to lower the pressure in the vessels to ensure a good injection. As a filling mass which gave not only roentgen-contrast but also colour-contrast, we used red lead (tri-plumbic-tetroxide, Pb_3O_4) with a 10 % solution of warm gelatin or glycerine.

In the work, the latest veterinary anatomical nomenclature is used (NAV, 1994).

Results

The testis of rabbit, as with the males of other mammals, is supplied by the *a. testicularis.* It originates (Plate I, Fig. 1,f) from the abdominal aorta caudally to the *a. renalis,* ventro-laterally or ventrally. The *a. testicularis dextra* emerges about 1-1.5 cm, sometimes only 0.5 cm in front of the *a. testicularis sinistra*. The right testicular artery arises approximately at the level of the fifth lumbar vertebra, the left at the level of the cranial part of the sixth lumbar vertebra. The *a. testicularis*, from its origin, runs caudo-ventrally as the *pars recta* in the wide *plica vasculosa*. Within the *canalis inguinalis*, which is long and wide in rabbits, the *pars recta* changes to the *pars convoluta* which is formed by 13-20 loose loops (Fig 1,f). At the *extremitas capitata* and along the *margo epididymis*, it approaches the *extremitas caudata*, where it perforates the *tunica albuginea* and continues as a subcapsular artery directly or tortuously through the *margo liber*. At the cranial end, it returns to the epididymal margin, where it forms slightly tortuous loops. At the *extremitas caudata* (in some cases also at the opposite testicular end) the testicular artery divides into two branches of almost equal thickness, which bend and continue around the testis, so that at the *margo liber* three arteries run side by side (Plate I, Fig 2, II, 3b). The small secondary intratesticular branches project from both marginal arteries (Plates II, III, Figs 2c, 3, 5b). The thicker of them, the *r. rete testis* enters the *mediastinum testis* which is shifted closely to the epididymal margin. From the *r. rete testis*, tiny *rr. interlobulares* (Plate II, Fig. 4c) originate in all directions; they run in the *septula testis* and reach the marginal branches and *tunica albuginea*. Several anastomoses are formed between the arteries of the free and epididymal margins (Fig 2c).

The epididymis is supplied by the branches of the blood vessels emanating from two sources:

a) the *a. testicularis* or its *pars convoluta*, from which originates the *r. epididymalis cranialis*, which vascularizes the epididymal head and fat pad (Fig 3, 5c). Before reaching the epididymal head the thin small branch (*r. epididymalis medius*), protrudes from the *a. testicularis* for the head and cranial part of the epididymal body (Fig 3d). The caudal part of the epididymal body and tail are supplied with the next branch of the *a. testicularis* – the *r. epididymalis caudalis*;

b) the *a. epididymalis caudalis*, which vascularizes the caudal part of the epididymal body and tail. It originates from the initial part of the *a. iliaca externa* either independently or from the *common trunk* (Fig. 1,g) whose branches also supply the *ductus deferens* and *m. cremaster*. The *a. epididymalis caudalis* above the epididymal tail is divided into 2–3 delicate branches (Figs 3,f), which enter the caudal part of the epididymal body and tail, where they run almost horizontally and give rise to more secondary branches. Some of them communicate with the *r. epididymalis caudalis*, with the terminal part of the *a. ductus deferentis* as well as with the intratesticular branches.

The *a. ductus deferentis* is a thin blood vessel, originating from the common trunk of the *a. iliaca externa* (Fig. 1,i). It runs along the *ductus deferens*, which it supplies. In the epididymal tail, it communicates with the terminal part of *a. epididymalis caudalis* and the *r. epididymalis caudalis*. A thin branch, the *r. cremastericus* for the ventral part of the *m. cremaster* originates above the *extremitas caudata* from the *r. ductus deferentis*.

The *a. cremasterica* originates from the above mentioned common trunk of the *a. iliaca externa* (Fig. 1j). Its several *rr. musculares* supply the *m. cremaster* and 1-3 *rr. adiposi* vascularize the caudal fat pad. The terminal branches of *a. cremasterica* enter the testicular coverings.

The following intratesticular communications have been found in our study:

a) in the region of the *extremitas capitata*: intratesticular branches of the testicular artery with branches from the *r. epididymalis cranialis* (Plates II, III, Figs 4, 6);

b) in the region of the *extremitas caudata*: intratesticular branches of the testicular artery with branches from *r. epididymalis caudalis* and *a. epididymalis caudalis* (Fig. 6, rings circle the anastomoses).

Discussion

The testes of rabbits, as with other species of mammals, supply the *aa. testiculares* (NAV, 1994). The origin of the testicular arteries from the aorta in male laboratory rodents varies according to species. In rats, it is situated close to the *aa. renales*; in some individuals, it also originates from the *aa. renales* or even from the *truncus iliacus communis* (Hebel and Stromberg 1976; Melman et al. 1985). In guinea-pigs and golden hamsters(Michel 1959; Cooper and Schiller 1975) the testicular arteries arise from the aorta at the level of the *aa. renales* or behind them, and in mice (Froud 1959) they emerge as branches from the *aa. renales* (Harrison 1949; Harrison and Weiner 1949; Chubb and Desjardins 1982) have not reported the exact sites of the origin of the *aa. testiculares* for the rabbit (Lagomorpha).Based upon our findings, the *aa. testiculares* arise irregularly from the aorta as some of its last branches. The right artery originates in front of the *a. mesenterica caudalis* (level with the fifth lumbar vertebra), the left at the *a. mesenterica caudalis* or behind it (level with the sixth lumbar vertebra). Only in two cases were the testicular arteries found to originate at the same level as reported by Popesko et al. (1992).

In all mammals, the *a. testicularis* has an abdominal part with a direct course (*pars recta*), while the part passing through the inguinal canal forms loops (*pars convoluta*). In some laboratory rodents, e.g. mice, these loops are missing or not apparent (Harrison and Weiner 1949; Suzuki 1982). According to Michel (1959) in the gold hamster the *pars convoluta* is formed by four big loops during the mating period, which in the rest period (during hibernation), however, are straightened. The *pars convoluta* in the rabbits studied runs throughout the inguinal canal, where it forms 13—20 loops. This data corresponds to that of Chubb and Desjardins (1982).

After reaching the testis, the *a. testicularis* of the rabbits studied perforates the *tunica albuginea* only in the proximity of the *extremitas caudata* and enters the parenchyma after encircling the testis twice (or three times). A similar arrangement of the *a. testicularis* in rabbits is reported by (Harrison (1949), Harrison and Weiner (1949), while in McLaughlin's (1972) study of the rabbit's anatomy, the arrangement of the *a. testicularis* is not mentioned.After the division of the *a. testicularis* under the *tunica albuginea* at the level of the *margo liber* of the testis, three arteries run side by side. A similar observation in rabbits was also recorded by Harrison (1949). One of the branches of the marginal arteries enters the *mediastinum testis* as the *r. rete testis*. Its fine *rr. interlobulares* run through the interlobular spaces. Neither Harrison (1949), Harrison and Weiner (1949) nor Chubb and Desjardins (1982) have reported the intraorgan arrangement of *a. testicularis* in the rabbit.

Harrison and Weiner (1949) considered the circular arrangement of the *a. testicularis* to be a part of thermoregulatory mechanism of the testis.

According to Chubb and Desjardins (1982), the epididymis of the rabbit is supplied by the *r. epididymalis superior* and *inferior* (in the sense of NAV 1994, these are known as

the *r. epididymalis cranialis* and *caudalis*) as direct branches from the *a. testicularis*. The independent origin of the branch for the epididymal head of the rabbit from the a. testicularis has also been described by Clavert at al. (1980). The same finding have been recorded in our material.

However, based upon our study, unlike the above-mentioned authors, part of the epididymal body and tail is also supplied by the *a. epididymalis caudalis*, originating from the common trunk of the initial part of the *a. iliaca externa*. This vessel has not been reported by Chubb and Desjardins (1982) or Popesko et al. (1992). The *a. ductus deferentis*, supplying the deferent duct and partially the epididymal head, originates independently or from the common trunk of the initial part of the *a. iliaca externa*. Its origin was also reported at the same site in the rabbit by Barone et al. (1973) and Popesko et al. (1992).

The *a. cremasterica*, serving not only the *m. cremaster* and caudal fat pad, but also the testicular coverings, represents according to our findings one of the branches of the common trunk of the *a. iliaca externa*. There is no mention in the literature of this small vessel its origin in connection with vascularization of the rabbit (Harrison 1949; Harrison and Weiner 1949; McLaughlin 1972; Barone et al. 1973; Chubb and Desjardins 1982; Popesko et al. 1992).

Krvenie semenníka, prisemenníka a semenovodu u králika. Tepny.

U 20 dospelých králikov bolo študované krvenie semenníka, prisemenníka a semenovodu pomocou röntgenu. Ako röntgenkontrastnú a farebnekontrastnú hmotu sme použili mínium v 10% teplej želatíne. Bol nájdený nerovnomerný vznik *aa. testiculares* z aorty. Semenníková tepna tvorí *pars recta* a *pars convoluta* s 13-20 voľnými slučkami, ktoré sa nachádzajú v slabinovom kanáli. Po vstupe do semenníka *a. testicularis* obtočí semenník pod *tunica albuginea* dvakrát. Jednou z intratestikulárnych vetiev je *r. rete testis* ktorý prechádza cez *mediastinum testis* a dá vzniknúť viacerým *rr. interlobulares*. Prisemenník krvia *rr. epididymales (cranialis, media* a *caudalis*) a *a. epididymalis caudalis*. Semenovod krví *a. ductus deferentis*, ktorá vzniká so spoločného kmeňa *a. iliacae externae*. *M. cremaster* je zásobovaný vetvami od *a. cremasterica*, ale aj od *a. ductus deferentis*. Terminálne vetvy od *a. cremasterica* vstupujú do obalov semenníka. Boli zistené anastomózy medzi intraparenchymálnymi vetvami *a. testicularis* s *rr. epididymales* ale aj s *a. epididymalis caudalis*. Naša práca dopĺňa tepnové zásobenie semenníka, prisemeníka a semenovodu u králika.

References

BARONE, R., PAVAUX, C., BLIN, P. C., CUQ, P. 1973: Atlas d' Anatomie du Lapin. Masson E., C Editeurs, Paris, 203 p.

CHUBB, C., DESJARDINS, C. 1982: Vasculature of the mouse, rat and rabbit testis – epididymis. Am. J. Anat. **165**: 357-372

CLAVERT, A., CRANZ, C., BRUN, B. 1980: Study of the vascularization of the epididymis (in French). Bull. Assoc. Anat. **64**: 539-546

COOPER, G., SCHILLER, A. L. 1975: Anatomy of the Guinea-Pig. Harvard University Press, Cambridge, Massachusetts, 403 pp.

FROUD, M. D. 1959: Studies on the arterial system of three inbred strains of mice. J. Morphol. **104**: 441-478

HARRISON, R. G. 1949: The comparative anatomy of the blood supply of the mammalian testis. Proc. Zool. Soc. London **119**: 325-344

HARRISON, R. G., WEINER, J. S. 1949: Vascular patterns of the mammalian testis and their functional significance. J. Exp. Biol. **26**: 304-316

HEBEL, R., STROMBERG, M. W. 1976: Anatomy of the Laboratory Rat. Wiliams and Wilkins, Baltimore, 173 pp.

KORMANO, M. 1967: An angiographic study of the testicular vasculature in the postnatal rat. Z. Anat. Entw. **126**: 138-153

Mc LAUGHLIN, CH. A. 1972: Laboratory Anatomy of the Rabbit. W. M. C. Brown Co. Publishers, Dubuque, Yowa, 112 pp.

MELMAN, E. P., GRATSULJAK, B. V., LOVSKAJA, R. N., PARASHACHIN, V. M. 1985: Correlations among vessels and tissues in the rat testis (*Rattus norvegicus* L.) normally and in experimentally distributed blood circulation. Zool. Jhrb, Anat. **113**: 435-476

MICHEL, G. 1959: Die Aufzweigung der Aorta abdominalis des Syr. Goldhamsters mit besonderer Berückschichtigung der männlichen und weiblichen Geschlechtsorgane. Anat. Anz. **107**: 111-125

NICKEL, R., SCHMUMMER, A., SEIFERLE, E. 1984: Lehrbuch der Anatomie der Haustiere. Bd. III. Kreislaufsystem, Haut und Hautorgane. Verlag Paul Parey, Berlin, Hamburg, 638 p.

NOMINA ANATOMICA VETERINARIA. 1994: IVth Ed., Zürich, Ithaca, New York, 198 p.

POPESKO, P., RAJTOVÁ, V., HORÁK, J. 1992: A colour Atlas of Anatomy of Small Laboratory Animals. Vol. I. Wolfe Publishing Ltd., London, 255 p.

SMALLWOOD, J. E. 1992: A Guided Tour of Veterinary Anatomy. W. B. Saunders Company, Philadelphia, London, Tokyo, 367 p.

SUZUKI, F. 1982: Microvasculature of the mouse testis and excurrent duct system. Am. J. Anat. **163**: 309-325

VRZGULOVÁ, M., HÁJOVSKÁ, B. 1968: Vascularization of rat testis and epididymis. A. Arteries. (in Slovak) Folia Vet. **XII**: 11-17

Plate I
Rajtová V. et al.: Vasculature... pp. 3–7

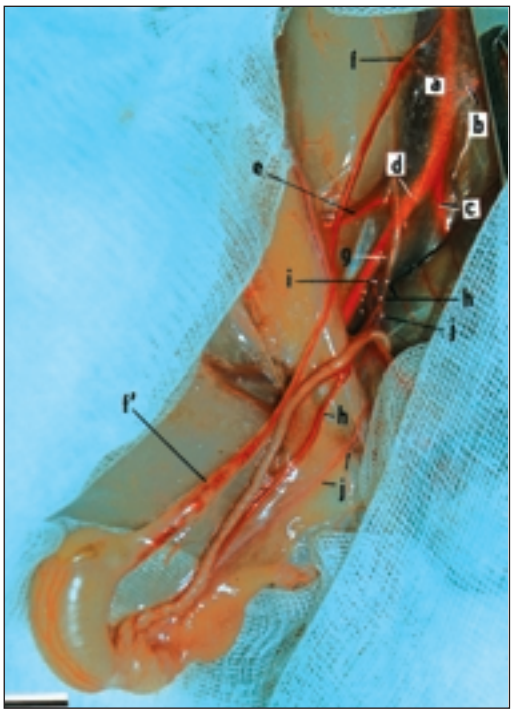

Fig. 1. The roof of the abdominal cavity with the caudal part of the *aorta abdominalis* and some of its branches. Ventral view. a - *aorta abdominalis*, b - a. *mesenterica caudalis*, c - *a. iliaca interna*, d - *a. iliaca externa*, e - *a. circumflexa ilium profunda*, f, f' - *a. testicularis*, f - *pars recta*, f' - *pars convoluta*, g- common trunk, h - *a. epididymalis caudalis*, i - *a. ductus deferentis*, j - *a. cremasterica*. Bar = 1 cm

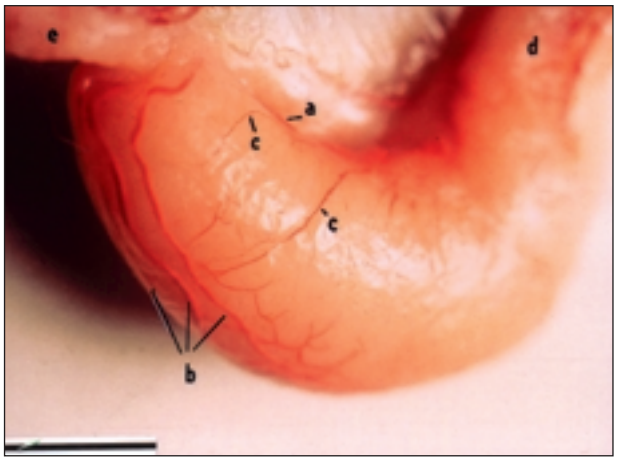

Fig. 2. The right testis. A lateral view. a - continuation of the *a. testicularis* through the *margo epididymalis*, b - ventral marginal testicular branches, c - anastomoses between dorsal and ventral marginal branches (a and b), d - part of the *funiculus spermaticus*, e - *cauda epididymis*. Bar = 1 cm

Plate II

Fig. 3. An angiograph of the arteries of the left testis and epididymis. a - *a. testicularis*, b - ventral marginal testicular branches, c - *r. epididymalis cranialis*, d - *r. epididymalis medius*, e - *r. epididymalis caudalis*, f - *a. epididymalis caudalis*. Bar = 1 cm

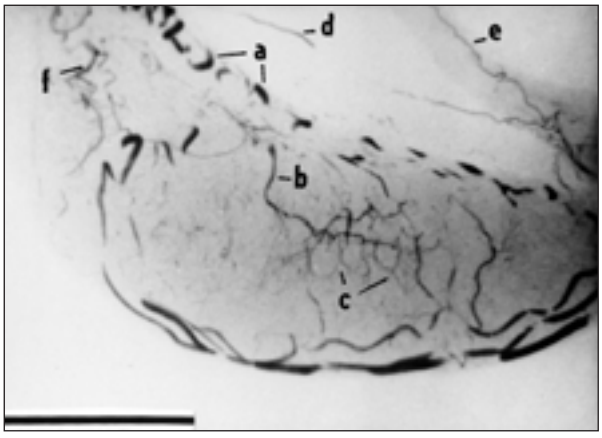

Fig. 4. An angiograph of the arteries of the right testis and epididymis. a - *a. testicularis*, b - *r. rete testis*, c - *rr. intralobulares*, d - *a. epididymalis caudalis*, e - *a. ductus deferentis*, f - branches of the *r. epididymalis cranialis*. Bar = 1 cm

Plate III

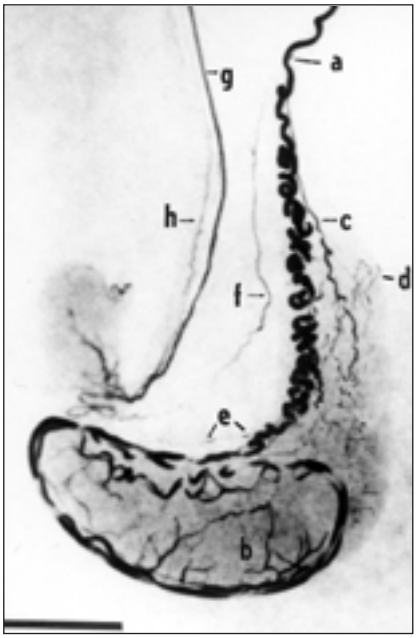

Fig. 5. An angiograph of the left testis and epididymis. a - *a. testicularis*, b - intratesticular branches, c - *r. epididymalis cranialis*, d - branches for the fat pad, e - part of the *r. epididymalis medius*, f - r. *epididymalis caudalis*, g - *a. epididymalis caudalis*, h - *a. ductus deferentis*. Bar = 1 cm

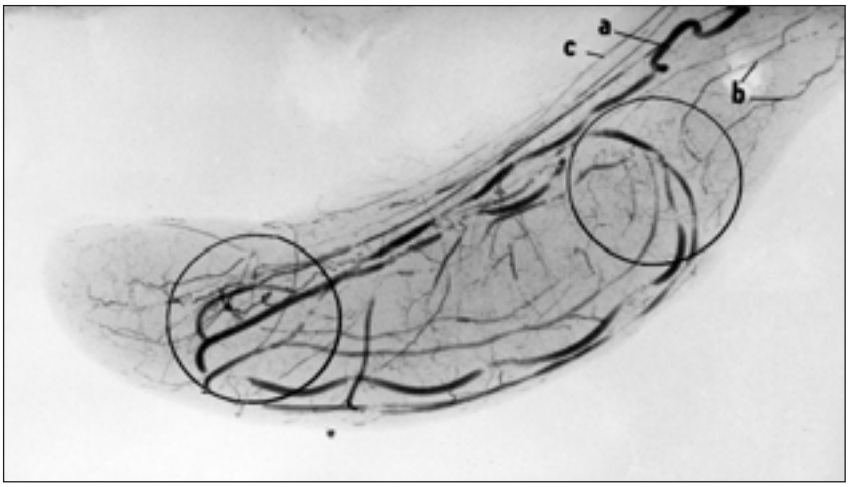

Fig. 6. An angiograph of the arteries of the left testis and epididymis. a - *a. testicularis*, b - branches from the *r. epididymalis cranialis*, c - part of the *r. epididymalis caudalis*. The rings circle the anastomoses of the intratesticular branches with branches from *r. epididymalis cranialis* and *caudalis*.

Plate IV
Vajner L. et al.: Mucin... pp. 9–13

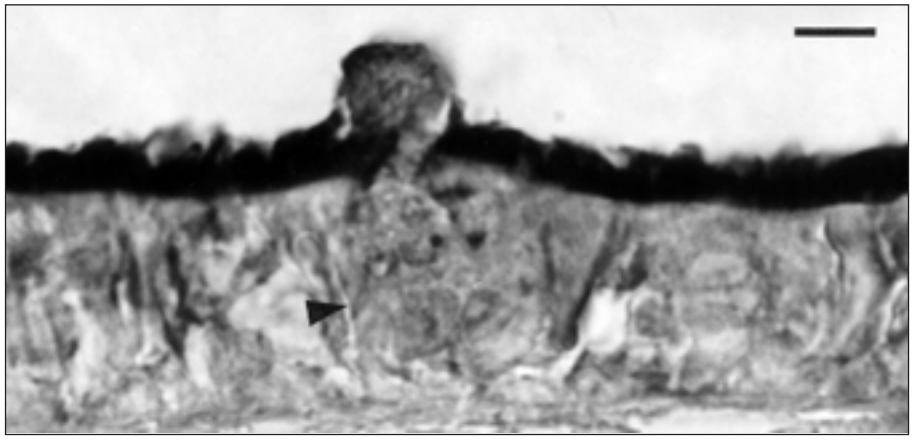

Fig. 1: Goblet cell releasing its secretion (arrow) 20 minutes after ambroxol administration. MAA reaction. Bar is equal to 10 µm.

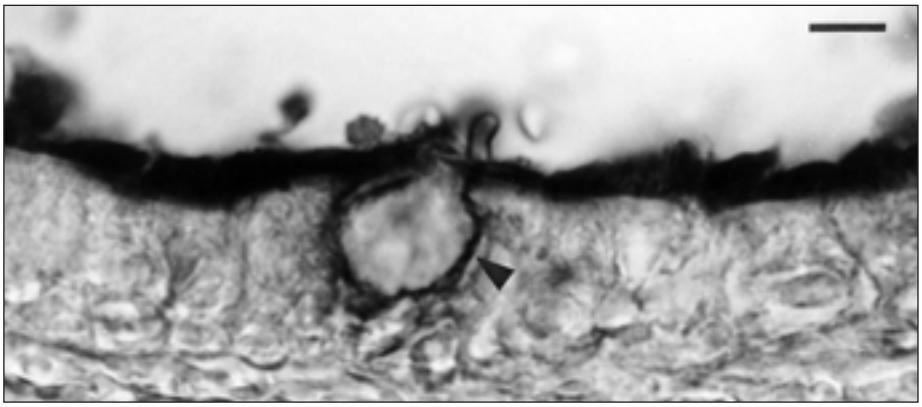

Fig. 2: Exhausted goblet cell (arrow) 20 minutes after ambroxol administration. MAA reaction. Bar is equal to 10 µm.

Plate V
Trávníček J. et al.: Iodine... pp. 35–42

Fig. 1. Thyroid gland of a kid affected by neonatal goitre