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Mast Cell Distribution in the Terminal Part of Porcine Ureter

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Abstract

The distribution of mast cells (MCs) in the terminal (intramural, intravesical) part of porcine ureter using toluidine blue staining was performed. It was established that in the *lamina propria mucosae* MCs were localized predominantly in the vicinity of blood vessels of the microcirculatory bed and rarely near the basal membrane of *lamina epithelialis mucosae*. In *tunica muscularis*, MCs were located mainly in the loose connective tissue around the blood vessels of the microcirculatory bed, as well as near the smooth muscle bundles. No statistical difference was estimated between number of Mcs/mm^2 in males and females in the *lamina propria mucosae*, while significant difference ($P<0.05$) was established between values in *tunica muscularis* comparing males and females. Statistical significant difference ($P<0.0001$) between values in *tunica muscularis* and *lamina propria* in each group of animals (in males and in females, respectively), was also found.

Key words: Mast cells, ureter-vesical junction, pig

Introdiction

The intramural part of ureter located within the dorsal urinary bladder wall, remains as independent organ among the bladder structures. It represents special anatomical, physiological and clinical interest, because that part like in man shows an anatomical narrowing in which urinary stones (ureteral calculi) could be retained. The latter sometimes provokes inflammation, spasm of musculature, particular or full obstruction, resulting in hydronephrosis or hydroureteronephrosis [1, 7].

That part of the ureter is responsible for protection of urine reflux from the bladder. The vesicoureteral reflux in combination with infection of the upper urinary tract and/or hydronephrosis bring often to kidney injuries [3].

Previous study convincingly demonstrated MCs localization in all layers of the extravesical parts of porcine ureter [10]. The evidence of some ligands as histamine

and vasoactive intestinal polypeptide (VIP) gave a reason to suggest that MCs take part not only in the maintenance of local homeostasis (microenvironment), but in the influence of smooth muscle motility as well. Recently, Lim et al. [2] confirmed that opinion, based on their results on isolated porcine distal ureter to 5-HT in young and old animals.

There is enough data that the swine is the most convenient animal model for performance of biomedical studies, results of which could be successfully interpreted and taken in mind for the human, including for the aims of xenotransplantation [4, 5, 6, 8, 9].

Materials and Methods

The intramural part of ureters from 6 males and 6 females 6-month-old pigs, 90 – 100 kg b. w. slaughtered for meat consumption according to Bulgarian laws were collected. Tissue pieces were immediately fixed in Carnoy's liquid for 24 h at room temperature, dehydrated in ascending ethanol lines, cleared in xylene and embedded in paraffin. After toluidine blue staining of 5 μm sections, only nucleated MCs expressing metachromasia were calculated on five serial sections of each organ (two fields with area of 1 mm^2 each per section). Data for density (number/mm^2) of MCs were estimated by Leica DM 1000 light microscope, digital camera Leica DFC 290 and software LAS V4.10.0 2016. The significance of difference (when $P < 0.05$) was assessed using one-way ANOVA.

Results

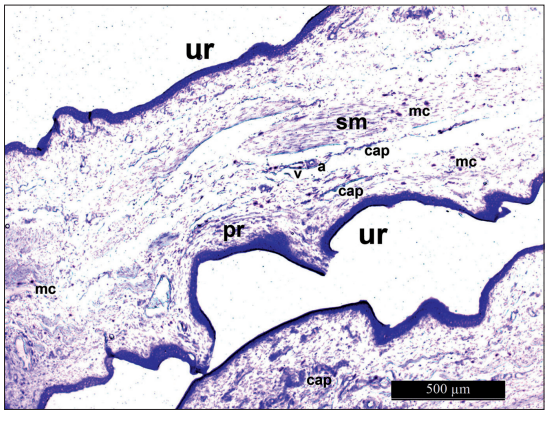

Fig. 1. Section through the terminal part of ureters (ur) into the urinary bladder wall of female pig mc – mast cells, sm – smooth muscle bundles, a – arteriola, v – venula and cap – capillaries of the microcirculatory bed. Toluidine blue staining. Bar = 500 μm.

MCs localization and density in both subepithelial connective tissue and muscle layer of intramural part of ureter were estimated. In the *lamina propria mucosae* MCs were observed predominantly in the vicinity of blood vessels of the microcirculatory bed and rarely near the basal membrane of *lamina epithelialis mucosae*. In *tunica muscularis*, MCs were located mainly in the loose connective tissue around the blood vessels of the microcirculatory bed, as well as near the smooth muscle bundles (**Figs.1, 2**). It should be noted that all of the observed mast cells showed well expressed γ-ma metachromasia.

It was detected a higher number of MCs in the muscle layer (86.60± 5.01 in males and 91.10±4.07 in females) compared to the mucosal propria in both males and females individuals (30.60±2.27 and 32.50±2.59, respectively) with $P < 0.0001$, (**Table 1**).The average number of mast cells in tunica muscularis was significantly higher in females than in males.

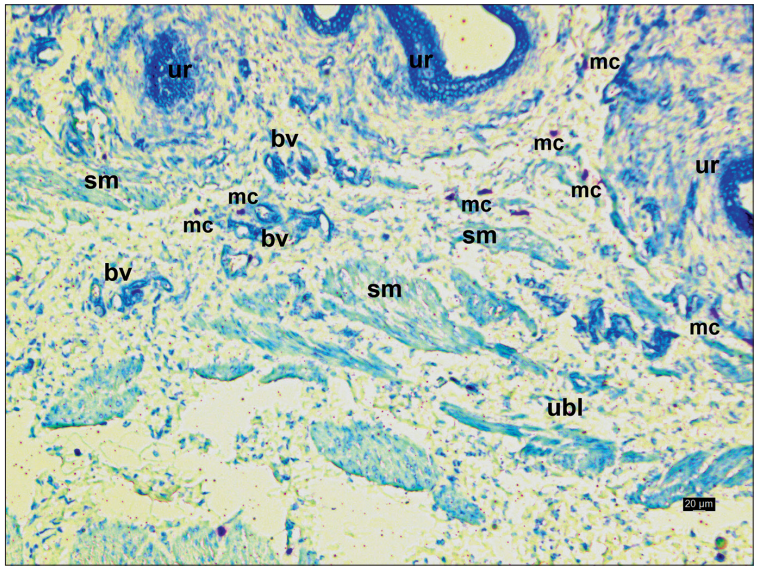

Fig. 2. Mast cells (mc) with expressed γ-ma metachromasia. ur –terminal part of male ureter, ubl – urinary bladder, sm – smoot muscle bundles. Toluidine blue staining. Bar = 10 µm.

Table 1. Distribution of mast cells (mm^2) in the terminal part of ureter's wall

Parameters	males	females
MCs number in: Lamina propria Min-max Tunica muscularis Min-max	 30.60±2.27 27-34 86.60±5.01**** **A** 78-93	 32.50±2.59 30-38 91.10±4.07**** 86-99

**** (P<0.0001) Statistical significant difference between values in *tunica muscularis and lamina propria* in each group of animals (in males and in females, respectively)
A (P<0.05) - Statistical significant difference between values in tunica muscularis comparing males and females
Min-max: minimal and maximal number of mast cells per mm^2 in each layer

Discussion

The current study presents original data about the distribution of mast cells in the wall of intramural part of the porcine ureter. The results allowed us to suggest that mast cells contribute not only in maintaining local microenvironment, but they are also important for the smooth muscle motility which is related to the regulation of urine flow via this part of the ureter.

Our previously study of MCs distribution in porcine abdominal part of the ureter showed that they are are located in all layers of this particular part of the ureter, but the highest number of them was estimated in the muscular sheet. Based on the results

of histo- and immunocytochemical investigation it was suggested that mast cells take important part not only in maintaining local homeostasis, but also in the motility of ureteral smooth muscle cells [10]. In addition, according to Lim et al. [2] mast cells presence in the ureter also play an important role in the regulation of ureteral motility via the release of mediators including histamine and 5-HT in inflammatory circumstances – it is possible that mast cell regulatory mechanisms occur via 5-HT receptor.

In general, the average number of mast cells found on mm^2 was a little higher in females than in males – 1.9-fold (lamina propria mucosae) and much more - 4.5-fold (tunica muscularis), respectively. The latter values also showed statistically significant difference. This fact is difficult to explain, but it could be presumed that the higher number of mast cells in the female ureteral muscle layer is related with more active participation in motility of smooth muscle cells and in keeping of local microenvironment in the intravesical part of the ureter.

Conclusion

This study presents original data about distribution of mast cells in the wall of the intramural part of the porcine ureter. The results allow us to suggest that mast cells contribute not only in maintaining local microenvironment but they are also important for the smooth muscle motility which is related to the regulation of urine flow via this part of the ureter.

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