
3. RESULTS

Figure 2 shows typical intravesical pressure and blood flow in two different rat bladders. Before the initiation of

2. METHODS

Eight male adult Wistar rats (approximately 300 g) male were used in this study. Under urethane anesthesia (1.0 g/kg bodyweight, s.c.), a lower abdominal midline incision was performed, and the bladder was exposed. Thereafter, cystometry was carried out with a 24 G catheter inserted into the apex of the bladder dome in order to fill the bladder with physiological saline (saline infusion speed: 6 mL/h) and record the bladder pressure. The bladder blood flow was measured by a laser Doppler flowmeter (BRL-100; Bioresearch Co., Nagoya, Japan) with a needle type probe (0.53 mm in diameter), which was inserted into the detrusor smooth muscle about 5 mm and was fixed twice with a 4-0 VICRYL suture (Ethicon Inc, West Somerville, NJ, USA). As bladder neck is relatively less moving compared to bladder apex during micturition, we tried to set the probe into the detrusor relatively close to bladder neck (Fig. 1). A personal computer (Macintosh G4, Apple, Cupertino, CA, USA) connected via a bridge amplifier (ML112, AD Instruments, Castle Hill, NSW, Australia) and multiport controller (PowerLab/16sp, AD Instruments) was used to record the data.

1. INTRODUCTION

The urinary bladder requires an adequate supply of oxygen and nutrients via the circulation system in order to maintain homeostasis and proper function.1,2 Previously, we reported the monitoring of bladder blood flow using a laser Doppler flowmeter.1,2 However, in our previous reports we have measured the bladder blood flow under pentobarbital anesthesia without measuring the contraction of the detrusor smooth muscle. This simultaneous real-time measurement of the blood flow in the bladder and the intravesical pressure during voiding is important to understand the pathophysiological conditions and their underlying mechanisms. However, there is only limited information available about the relationship between voiding cycle and bladder blood flow in small animals, such as rats and mice. In the present study, we tried to perform simultaneously monitoring blood flow and intravesical pressure during the micturition cycle in a rat model.

Key words bladder blood flow, intravesical pressure, rat
Fig. 1 A schema of our experiment in the bladder. Cystometry was carried out with a 24 G catheter inserted into the apex of the bladder dome. To measure the bladder blood flow, a needle type probe (0.53 mm in diameter) was inserted into the detrusor smooth muscle about 5 mm and fixed twice with a 4-0 VICRYL suture.

Fig. 2 (a,c) Intravesical pressure and (b,d) bladder blood flow in the voiding cycle of two different rats. Significant decreases in blood flow were observed after voiding in both rats (arrows).

the micturition reflex, a significant increase in blood flow was observed, and this increased the bladder blood flow which continued during the micturition reflex. Under the maximum contraction pressure, blood flow rapidly decreased (within 10% compared to the max level). This low level of blood flow continued for more than half a minute. Our data indicated that rat bladder smooth muscle is under partial ischemia during voiding.

4. DISCUSSION

Technically, it was difficult to measure blood flow in the rat bladder while the animals were voiding. In this study, we were able to successfully monitor the blood flow and intravesical pressure simultaneously during the voiding cycle in a rat model. Before micturition, a significant increase in the bladder blood flow was observed. Kershen
et al. reported that human bladder blood flow increases with increasing volume and pressure in the filling phase. Their results showed that there is a complex biphasic relationship among bladder volume, intravesical pressure and microcirculatory resistance in the bladder. They explained these observations proposing an anatomical and a neurophysiological hypothesis. These observations may explain why, in the contraction of the detrusor muscle, a great deal of energy, including glucose and oxygen, is required physiologically. In the maximum contraction of the detrusor, vessels in the detrusor are compressed in the bladder. Greenland and Brading reported that after voiding in a normal-compliance bladder, a significant decrease in bladder blood flow takes place in a conscious pig model. However, as far as we know, there is no information available about relationship between voiding cycle and bladder blood flow in small animals, such as rats and mice. In the present study, we observed significant phenomena. The first finding was a significant increase in blood flow prior to the micturition reflex, which may result in part from the spinal reflex, but the detailed mechanisms are still unclear. The second finding was the ischemic phase in the bladder.

Although for big animals such as pigs, dogs and monkeys, it is not difficult to monitor bladder blood flow during voiding, the cost for the experiment is quite expensive, and it is difficult to be performed widely. In this study we successfully monitored the intravesical pressure and blood flow in the rat bladder, and this technique may represent a strong tool to investigate bladder function under drug administrations and/or pathophysiological conditions.

Disclosure

We have no substantial direct or indirect financial incentive associated with publication of this article. No funding agreement limits our ability to complete and publish this research. We have full control of the primary data presented.

REFERENCES