

URODYNAMIC METHODS IN THE EVALUATION OF THE LOWER URINARY SYSTEM

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1. INTRODUCTION

The purpose of this paper is to describe the biomedical instrumentation routinely used in the Urodynamics Laboratory at Stanford to monitor and assess bladder and urethral function. In principle this instrumentation is designed to evaluate the primary function of the bladder as a storage viscus and that of the urethra as an outlet valve. Under physiologic conditions the bladder and urethra work synergistically; storage of urine proceeding sub-consciously and very slowly, whereas evacuation is initiated at will and lasts less than one minute. In outlining the material of this presentation the clinical tests used in each phase of a urodynamics study will be illustrated with sample recordings to demonstrate the signal qualities and transducer sensitivities best suited for the objective evaluation of the lower urinary system.

2. METHODS

A principal prerequisite in the execution of a urodynamic study is the minimization of catheter invasion to the patient. The scheme chosen here reduces the number of catheterizations to a minimum. To achieve this a double lumen silicon catheter is inserted through the urethra into the bladder. One lumen of the catheter is used for filling the bladder through a pump with warm saline, while the other lumen records bladder pressure on a strain gauge transducer. With this arrangement the pressure/time curve cystometrogram of the bladder can be recorded on a polygraph. Since filling is made through a pump the horizontal scale of the polygraph paper also represents bladder volume. As the physiological filling rate of the bladder is slow, this study is carried out at a modest flow rate of 10 ml/min. Simultaneously with bladder filling it is necessary to monitor the pressures present around the bladder. Thus a rectal balloon is inserted into the rectum and inflated so that the wall of the balloon approximates the mucosa. In this way extraneous pressures not originating in the bladder wall can be identified. The two pressure measurements are essentially of low frequency < 1 Hz and can, therefore, be recorded on a low frequency response pen recorder. In addition to these two pressures the electrical activity of the urethral sphincter is measured using a pair of platinum needle electrodes. However, in order to record the activity of the urethral sphincter it is necessary to measure the motor neuron frequency. The useful frequency spectrum for the electromyography of the urethral sphincter is up to 3 KHz as demonstrated in Figure 1. For continuous monitoring this signal is observed on the oscilloscope. It is thus necessary for the simultaneous recording of the above three signals to use a photosensitive paper with adequate frequency response.



Fig. 1. Motor unit activity of urethral sphincter recorded indirectly from macroelectrodes placed in the anal sphincter.

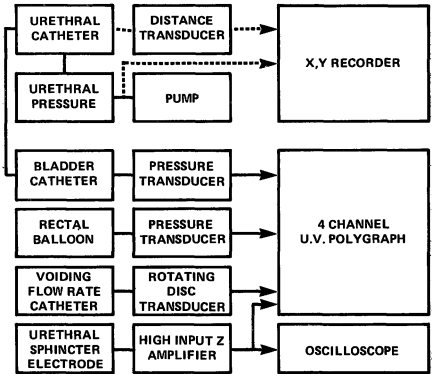


Fig. 2. Block diagram of the transducer and recording apparatus used for urodynamics. The interconnection with a broken line indicates system used during urethral pressure profile.

The pressure in the urethral sphincter is measured using the same double lumen catheter used above. This catheter is mounted on a platform which is so constructed as to measure the distance moved while the catheter is withdrawn. The pressure distribution along the length of the urethra is thus recorded using an X, Y recorder. The vertical axis representing pressure and the horizontal, distance from the neck of the bladder. An additional recording made during these studies is urine flow