Simulation Systems for Stress Incontinence

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INTRODUCTION

The currently used implant for severe incontinence is the urinary control system AMS 800™ with one or two cuffs as the artificial sphincter. The system is often revised because of urethral atrophy. We have realized an in vitro testing system to study the efficacy of the implant under steady state and dynamic conditions to optimize the cuff geometry. The experiments are based on explanted human and animal (sow) urethras. The behaviour of explanted urethras may differ from the in vivo situation, because blood flow and pressure are suppressed. To determine the influence of the aging on the mechanical properties, the experiments have been repeated for several times. The influence of the aging process was much smaller than the difference from one urethra to another.

COMPRESSION MODEL

The urinary bladder generates the pressure acting on the urethral sphincter termed the vesical pressure. The vesical leak point pressure (vLPP) is defined as the lowest vesical pressure necessary for leakage. For constant vesical pressure, the sphincter pressure when the urethra opens is termed the external urethral leak point pressure (euLPP).

\[ \text{euLPP} = (\text{vLPP} + p_W) \left( 1 + \frac{2 \text{Lp}}{L} \right) + \frac{F_R}{L_R} \]

This equation shows the experimentally proven linear dependence of vLPP and euLPP and the observed decrease of euLPP versus sphincter length L.

RESULTS

Comparing peak pressure versus euLPP for one or two cuffs and different human urethras, the experimental data show that the distal cuff was advantageous for Urethra 1, but did not result in a difference for Urethra 2.

Urethra 1 was soft enough to inflate during pressure impulse. For Urethra 2 inflation was suppressed, corresponding to the behaviour of a stiff urethra. Hence the second cuff is only advantageous if

- the (soft) urethra reduces the efficacy of the proximal cuff due to shape changes or
- the urethras are inhomogeneous, verified also by measurements with sow urethras.

CONCLUSION AND ACKNOWLEDGEMENT

If the urethra is soft, it inflates, and the proximal cuff, which helps the distal cuff to remain its shape, opens. Thus, the implantation of a second cuff is recommended. In case of radical prostatectomy, scar tissue formation often prevents the ability of the urethra to inflate. Since the urethra is inhomogeneous, the second cuff might be better positioned and therefore useful. The two cuffs should be placed without gap as quantitatively derived from the compression model. The supply of the AMS 800 by F. Bönzli, Promedics and the support of the Institute for Veterinary Pathology, University of Zürich is gratefully acknowledged.