# Functional and Structural Changes of the Pelvic Floor in Ageing Women

Gin-Den Chen, M.D., Soo-Cheen Ng, M.D.

Department of Obstetrics and Gynecology, Chung Shan Medical University Hospital, Taichung, Taiwan

## ABSTRACT

The occurrence of pelvic floor dysfunction may increase steadily during the ageing process in women. These pelvic floor dysfunctions may include aspects of micturition, defecation, prolapse, and sex. The natural history and mechanism of pelvic floor dysfunction in aged women are not well understood or explored. In this article, we review the age effect on the prevalence of pelvic floor dysfunction, and on the structural and functional changes of the lower urinary tract, anorectum and pelvic floor. Added together, the ageing process has a negative impact on either the function or structure of the lower urinary tract, the anorectum and the pelvic floor in women.

*Key words:* ageing, anal function, lower urinary tract dysfunction, pelvic floor dysfunction

## INTRODUCTION

Pelvic floor dysfunction impairs the lives (or quality of life) of a large number of women of all ages throughout the world. A higher life expectancy, owing to modern medical achievement, has added about 10 years (or even more) to a woman's previous life expectancy of 65 years. The occurrence of pelvic floor dysfunction may increase steadily during the ageing process in women [1]. However, there are a limited number of studies that have assessed the effect of age on the structure and function of the pelvic floor in the absence of disease [2]. Estimates of the prevalence of pelvic floor dysfunction in this population vary widely because of the absence of standardized and well-validated definitions and measures. Interpretation of data derived from epidemiology surveys is also difficult because levels of dependency may differ in different residential settings and in different countries.

The natural history of pelvic floor dysfunction in aged women is not well understood. In the past, parity and mode of delivery [3] were included in epidemiological studies, and later menopausal estrogen deficiency, higher BMI, previous pelvic surgery, and co-mobility such as DM, and hypertension history were also included in the epidemiological studies to evaluate the potential contributory factors for the occurrence of symptoms of pelvic floor dysfunction in women [4-7]. Some co-mobilities may co-exist in women with increasing age and frailty. For the sake of judging the effect of ageing on the pelvic floor function, these potential predisposing factors should be seen as confounding or the add-on effects through the whole life time of women which still needs a longitudinal study to clarify this issue. In our opinion, the functional and structural changes of the pelvic floor in ageing women are the carry-over (or so-called summative) effects of the above factors together.

Received: May 30, 2007 Accepted: June 13, 2007
Address correspondence to: Dr. Gin-Den Chen, Department of Obstetrics and Gynecology, Chung Shan Medical University Hospital, 110, Section 1, Chien Kuo North Road, Taichung, Taiwan
E-mail: gdchen@hotmail.com

## PREVALENCE OF SYMPTOMS OF PELVIC FLOOR DYSFUNCTION IN AGEING WOMEN

Pelvic floor symptoms, including five groups of dysfunctions such as micturition, defecation, prolapse, sex and pain, are known to increase with age [1]. In our previous studies, we found that lower urinary tract symptoms during filling and voiding phrase are not only affected by pre- to postmenopausal transition but are also closely associated with ageing changes [8]. The odds ratio for the presence of an overactive bladder (OAB) in community women over 65 years old was 1.49 [5]. Another study conducted for the hospital- based patients showed that female OAB syndrome was a highly prevalent condition in each birth cohort with a statistically significant increase with advancing age (65 years or older) [7]. The results of our survey in Taiwan were similar to the results found in the US and Europe [9,10]. The National Overactive Bladder Evaluation (NOBLE) Program US survey results showed that age-specific prevalence of OAB wet (OAB with urge incontinence) continues to increase with increasing age. Moreover, at older ages, the transition rate from OAB without to OAB with urge incontinence may exceed the rate of occurrence of new cases of OAB without incontinence [9]. The population-based prevalence of overactive bladder symptoms among men and women aged 40 years or older from six European countries revealed that the overall prevalence of OAB in individuals aged 40 years or older was 16.6%. However, the prevalence of OAB elevates after the age of 65 years (65-69: 17.5%; 70-74: 22.1%; aged 75 years or older: 31.3%). Goepel et al also showed that women 50-59 years old women have an odds ratio of frequency, urgency, urge incontinence and stress incontinence of greater than 5, and greater than 8 for the above symptoms for those aged 60-79 years, and greater than 20 for the above symptoms for woman 80 years old or older [11]. Our previous study also demonstrated that the increasing occurrence of nocturia is age-related and is not affected by the transition from pre- to postmenopause in community women [12].

In the past, voiding difficulty, defined as abnormally slow and/or incomplete micturition, has been relatively overlooked as a diagnosis in comparison with urodynamic stress incontinence, OAB and uterovaginal prolapse [13]. Haylen et al analyzed 592 women, with a median age of 57 years (range 16-98), with symptoms of lower urinary dysfunction and found that the prevalence of voiding difficulty was 39% for women who were referred for an initial urogynecological assessment including urodynamics. The prevalence of voiding difficulty increased significantly in prevalence with age and grades of all types of uterovaginal prolapse also increased. More than 60 % of women with voiding difficulty had a maximal flow rate under the 10th percentile of the equivalent Lverpool Nomogram [14] and/or a residual urine volume of more than 30 mL.

In addition to an increased presence of lower urinary tract dysfunction with age, in our previous community survey in 1999, we found that there was no significant difference of occurrence of anal incontinence among each birth cohorts (cohorts were divided into decades beginning with 20 years olds and finishing with women older than 65 years included in the same birth cohort), and the prevalence of anal incontinence did not increase after the age of 65 years. However, the prevalence of constipation increased significantly in elderly women aged 65 years and over and one-fourth of women with constipation, in our study, needed to take laxatives for defecation [6]. Data derived from the epidemiology of constipation in the United States shows that the prevalence of constipation increases in the sixth decade of life and one-third of elderly patients complain of constipation [15].

Our study in 2002 revealed an inconsistent result compared to that which was found in community women. Three hundred and eight women, mean age 45.14 years, were referred to our urogynecology outpatient clinic for urodynamic evaluation. We found that 31.5% of women with lower urinary tract symptoms had constipation, the prevalence was much higher than in the general population [16]. But there was no significant difference of a higher prevalence of constipation in elderly women. The odds ratio for elderly women with anal incontinence was 1.77 with a 95% confidence interval: 0.33-9.41 and for constipation the ratio was 2.18 with a 95% of confidence interval: 0.354-8.87.

The first comprehensive population survey of pelvic floor dysfunction was conducted on South Australian adults (15 years and older) in 1998. All participants were interviewed by trained female interviewers. The results can be summarized that, the overall, prevalence of pelvic floor disorders including urinary incontinence, anal incontinence, previously pelvic repairs, difficulty with defecation, and hemorrhoids is greater in women aged 65 years and older.

## CHANGES OF PELVIC FLOOR FUNCTION DURING AGEING PROCESS

Our hospital- based study shows that the prevalence of OAB syndrome increases significantly with advancing age (65 years or older). Patients with OAB wet are as high as 33.3 % in women after the age of 65 years [7]. However, the elderly have an increased tendency towards incomplete bladder emptying and this frequently co-exists with detrusor instability [17]. A series of studies by Griffiths et al showed that elderly patients may have under perfusion of the frontal lobes of the cerebral cortex (reflecting regional impairment of function) which appears to be causally related to urge incontinence and reduced bladder sensation [18]. They also demonstrated that factors such as reduced sensation of bladder filling, previous bacteriuria, elevated fluid intake, and infrequent voiding may contribute to severity of urine leakage in elderly patients [19]. Incomplete bladder emptying which elevates post-void residual may be caused by impaired detrusor contractility. The impaired detrusor contractility in elderly patients may have two aspects: elevated post-void residual urine volume and reduced detrusor contraction strength. Griffith et al defined a patient with urge incontinence, poor detrusor contractility, and elevated residual urine without urethral obstruction as having detrusor hyperactivity with impaired contractile (DHIC) function [20]. These kinds of functional impairments may be found in elderly patients and present as a challenging clinical problem for these patients. However, voiding disorders in the elderly may occur in the absence of symptoms. Therefore, it is not clear which patients with voiding disorders can be safely left unattended [21].

In addition to changes in the central nervous system, the function of peripheral nerves may also attenuate during the ageing process. Gilpin et al found that a significant linear reduction in the amount of acetylcholoneesterase-postive nerves and reduction in the number of nerve axons in human detrusor muscle tissue take place with increasing age [22]. This phenomenon may be associated with a variety of functional bladder impairments in advanced age. Homma et al conducted a survey and urodynamics on an elderly population who had no spontaneous complaints of symptoms and revealed that nearly all of the urinary symptoms increased with age. They also found that the detrusor function such as maximal detrusor pressure and maximal flow rate progressively deteriorated with age in women [23]. Urethral pressure may also be affected by ageing. Trowbridge et al discovered that increasing age is associated with a decreasing maximal urethral closure pressure averaging a 15 $cmH_2O$ drop per decade in nulliparous women [24].

Anorectal function may also deteriorate during the ageing process. We found that ageing is closely associated with reduced anaorectal pressure in our anal continent women with lower urinary tract symptoms [25]. Ageing was associated with lower anal resting and squeeze pressure, reduced rectal compliance, reduced rectal sensation, and perineal laxity, which were assessed by manometry, staircase balloon distension, and a visual analog scale during phasic distentions respectively. Pelvic magnetic resonance imaging also revealed the location of the anorectal junction at rest, squeeze, and Valsalva maneuver are lower in elderly women and these changes are associated with age [26]. Together, these changes may predispose elderly females to fecal incontinence.

Neural function and related pelvic floor muscle weakness have been measured with electromyography. Aukee et al, using a vaginal surface electromyography probe to measure the electromyography activity, revealed that in regression analysis electromyography values were dependent on age whether in supine or standing position in both incontinent patients and asymptomatic women, but not on parity, body mass index, or episiotomy [27]. They found that the electromyography activity of pelvic floor muscles decreased during the ageing process. The effect of age on denervation of the pelvic floor was reported by Allen and Darrell [28]. They found a gradual denervation with advancing years, which was more pronounced in parous women. Thus it seems likely that neurological damage from vaginal delivery, surgery, neuropathy and ageing has a role in the development of pelvic floor failure [29]. Olsen et al conducted a study in 2003 that tried to establish data for normative distributions for pudendal and perineal nerve compound muscle action potential in healthy women across a wide age range and varied history of vaginal deliveries. They studied 42 continent women, aged 20 to 67 years, including 29% nulliparous women to evaluate their pudendal terminal latency and amplitude and perineal nerve responses. Their data show that increasing age, more vaginal deliveries, and widening urogenital hiatus are associated with increased latency and decreased amplitude. Although it remains difficult to precisely quantify their specific contributions of these three variables. They suggest that the effects of age and parity must be recognized when interpreting pelvic nerve conduction study results. They also confirm that advancing age has an important effect on the normal limits for puden-

dal and perineal latency and amplitude [30].

## STRUCTURAL CHANGES OF PELVIC FLOOR DURING AGEING PROCESS

The age-related decrease in mean urethral closure pressure found in nulliparous women may corroborate and extend a similar finding in groups containing multiparous women. These functional changes most likely reflect histological changes seen in urethral striated muscle, blood vessels, and connective tissue of the urethra [24]. Perucchini et al found that with age there is a decrease in the muscle fiber to connective tissue ratio and muscle fiber diameter in the urethral sphincter [31]. The connective tissue to muscle ratio and the strength of skeletal muscle deteriorate with age. Thus, these same age-related changes may occur in the pelvic floor, leading to poorer support in older women.

Perucchini collaborated with DeLancey's laboratory to study 25 female cadavers, with a mean age of 52 years, ranging from 15-80 years, and found age effects on urethral striated muscle [32,33]. They reported that the number and density of urethral striated muscle fibers, not fiber diameter, in the ventral wall of the striated urogenital sphincter decline significantly with age. They estimates that over a life span, an average of 364 fibers (2%) are lost per year and mean fiber density also decreases by 13 fibers/mm2 per year [32]. Later, they did another study to measure the thickness of urethral muscle layers at specificlocations and along the length of the urethra. They also demonstrated that the striated muscle loss in the proximal ventral and dorsal urogenital sphincter muscle occurs with advancing age. Muscle loss in this portion of the urethra with advancing age might explain progressive reduction of urethral closure pressure that occurs with age [34]. A study by Boreham et al revealed that the fraction of smooth muscle in the muscularis of the anterior vaginal wall decreases significantly decreased in women with pelvic organ prolapse compared with normal control subjects using an immunohistochemistry study and morphometric analysis [35]. The fraction of smooth muscle in the anterior vaginal wall decreases significantly in women at age 60 or older than that in women under 50 years old. Lin et al investigated the changes in the connective tissues located in the upper portion of the anterior vaginal wall of women with or without prolapse and also found that quantitative immunoreactivity of collagen I and III have significant positive correlations with ageing [36].

Similar findings of age-related changes may also be found in the anal sphincter. Rociu et al performed high-spatial-resolution endoanal magnetic resonance imaging to assess sex-and age-related variations in the dimensions of the anal sphincter from 100 health volunteers (50 women and 50 men, evenly distributed between 20 and 85 years old). They found a significant decrease in the thickness of the longitudinal muscle and an increase in the thickness of the internal sphincter with advancing age in both sexes. There is also an age-related decrease in the thickness of the external sphincter but it is not a significant change.

## CONCLUSION

The natural history and mechanism of pelvic floor dysfunction in aged women are not well understood or explored. The ageing process seems to play a negative role in either the function or structure of the pelvic floor in women. Ageing may add to the deterioration of the pre-existing pelvic floor dysfunction during the life span of a woman. Or ageing may interact with other potential predisposing factors such as parity and mode of delivery, menopausal estrogen deficiency, higher BMI, previous pelvic surgery, and co-mobility including DM, hypertension and poor cognitive function etc. to cause predominant pelvic floor failure.

## ACKNOWLEDGEMENT

This manuscript is a review article and is written based on the talk at the symposium entitled "Epidemiology and perception of incontinence in ageing people (I)" on June 9, 2007 in Taipei. The editor of the journal of Incontinence and Pelvic Floor Dysfunction, which is the office journal of the Taiwanese Continence Society and the Taiwan Urogynecology Association, invited me to collect all references and write an article as a supplement to Incontinence and Pelvic Floor Dysfunction. I greatly appreciate that the editor of Incontinence and Pelvic Floor Dysfunction kindly allowed me to submit this manuscript to the Taiwanese Journal of Obstetrics and Gynecology as a review article simultaneously. The title of this manuscript will be changed as "Pelvic Floor Dysfunction in Ageing Women".

## REFERENCES

1. Mant J, Painter R, Vessey M: Epidemiology of genital prolapse: Observation from the Oxford Family Planning Association Study. Br J Obstet Gynecol 1997; **104**:579-585.
2. Jundt K, Kiening M, Fischer P, et al: Is the histomorphological concept of the female plelvic floor and its changes due to age and vaginal delivery correct? Neurourol Urodyn 2005; **24**:44-50.
3. MacLennan AH, Taylor AW, Wilson DH, Wilson D: The prevalence of pelvic floor disorders and their relationship to gender, age, parity, and mode of delivery. BJOG 2000; **107**:1460-1470.
4. Ng SC, Chen YC, Lin LY, Chen GD: Anorectal dysfunction in women with urinary incontinence or lower urinary tract symptoms. Int J Gynaecol Obstet 2002; **77**:139-145.
5. Chen GD, Lin TL, Hu SW, Chen YC, Lin LY: Prevalence and correlation of urinary incontinence and overactive bladder in Taiwanese women. Neurourol Urodyn 2003; **22**:109-117.
6. Chen GD, Hu SW, Chen YC, Lin TL, Lin LY: Prevalence and correlations of anal incontinence and constipation in Taiwanese women. Neurourol Urodyn 2003; **22**:664-669.
7. Hung MJ, Ho ES, Shen PS, et al: Urgency is the core symptom of the female overactive bladder syndrome, as demonstrated by a statistical analysis. J Urol 2006; **176**:636-640.
8. Chen YC, Chen GD, Hu SW, Lin TL, Lin LY: Is the occurrence of storage and voiding dysfunction affected by menopausal transition or associated with the normal aging process? Menopause 2003; **10**:203-208.
9. Stewart WF, Van Rooyen JB, Cundiff GW, et al: Prevalence and burden of overactive bladder in the United States. World J Urol 2003; **20**:327-336.
10. Milsom I, Abrams P, Cardozo L, Roberts RG, Thuroff J, Wein AJ: How widespread are the symptoms of an overactive bladder and how are they managed? A population-based prevalence study. BJU Int 2001; **87**:760-766.
11. Goepel M, Hoffmann JA, Piro M, Rubben H, Michel MC: Prevalence and physicaian awareness of symptoms of urinary bladder dysfunction. Eur Urol 2002; **41**:234-239.
12. Lin TL, Ng SC, Chen YC, Hu SW, Chen GD: What affects the occurrence of nocturia more: Menopause or age? Maturitas 2005: **50**:71-77.

13. Haylen BT, Krishnan S, Schulz S, et al: Has the true prevalence of voiding difficulty in urogynecology patients been underestimated? Int Urogynecol J Pelvic Floor Dysfunct 2007; **18**:53-56.
14. Haylen BT, Ashby D, Sutherst JR, Frazer MI, West CR: Maximum and average urine flow rates in normal male and female populations — the Liverpool nomogram. Br J Urol 1989; **64**:30-38.
15. Whitehead WE, Drinkwater D, Cheskin LJ, Heller BR, Schuster MM: Constipation in the elderly living at home: Definition, prevalence, and relationship to lifestyle and health status. J Am Geriatr Soc 1989; **37**:423-429.
16. Johanson JF, Sonnenberg A, Koch TR: Clinical epidemiology of chronic constipation. J Clin Gastroenterol 1989; **11**:525-536.
17. Malone-Lee JG, Wahedna I: Characterisation of detrusor contractile function in retation to old age. Br J Urol 1993; **72**:873-880.
18. Griffiths DJ, McCracken PN, Harrison GM, et al: Cerebral a etiology of urinary urge incontinence in eldrly people. Age Ageing 1994; **23**: 246-550.
19. Griffiths DJ, McCracken PN, Harrison GM, Gormley EA: Characteristics of urinary incontinence in elderly patients studied by 24-hour monitoring and urodynamic testing. Age Ageing 1992; **21**:195-201.
20. Griffiths DJ, McCracken PN, Harrison GM, Gormley EA, Moore KN: Urge incontinence and impaired detrusor contractility in the elderly. Neurourol Urodyn 2002; **21**:126-131.
21. Smith NK, Morrant JD: Post-operative urinary retention in women: Management by intermittent catheterization. Age Ageing 1990; **19**: 337-340.
22. Gilpin SA, Gilpin CJ, Dixon JS, Gosling JA, Kirby RS: The effect of age on the autonomic innervation of the urinary bladder. Br J Urol 1986; **58**:378-381.
23. Homma Y, Imajo C, Takahashi S, Kawabe K, Aso Y: Urinary symptoms and urodynamics in a normal elderly population. Scand J Urol Nephrol Suppl 1994; **157**:27-30.
24. Trowbridge ER, Wei JT, Fenner DE, Ashton-Miller JA, Delancey JO: Effects of ageing on lower urinary tract and pelvic floor function in nulliparous women. Obsetet Gynecol 2007; **109**:715-720.
25. Ng SC, Chen GD: Age effects on anorectal pressure in anal continent women with lower urinary tract dysfunction. Int Urogynecol J Pelvic Floor Dysfunct 2007; **18**:295-300.
26. Fox JC, Fletcher JG, Zinsmeister AR, Seide B, Riederer SJ, Bharucha AE: Effect of ageing on anorectal and pelvic floor functions in females. Dis Colon Rectum 2006; **49**:1726-1735.
27. Aukee P, Penttinen J, Airaksinen O: The effect of ageing on the electromyographic activity of pelvic floor muscles: A comparative study among stress incontinent patients and asymptomatic women. Maturitas 2003; **44**:253-257.
28. Allen RE, Warrell DW: The role of pregnancy and childbirth in partial denervation of the pelvic floor. Neurourol Urodyn 1992; **6**:183-184.
29. Bidmead J, Cardozo LD: Pelvic floor changes in the older women. Br J Urol 1998; **82(Suppl 1)**:18-25.
30. Olsen AL, Ross M, Stansfield RB, Kreiter C: Pelvic floor nerve conduction studies: Establishing clinically relevant normative data. Am J Obstet Gynecol 2003; **189**:1114-1119.
31. Perucchini D, DeLancey JOL, Blavivas M: Evidence of major myopathic changes in the striated urethral sphincter muscle in the female. Neurourol Urodyn 1997; **15**:394-395.
32. Perucchini D, DeLancey JO, Ashton-Miller JA, Peschers U, Kataria T: Age effects on urethral striated muscle. I. Changes in number and diameter of striated muscle fibers in the ventral urethra. Am J Obstet Gynecol 2002; **186**:351-355.
33. Perucchini D, DeLancey JO, Ashton-Miller JA, Galecki A, Schaer GN: Age effects on urethral striated muscle. II. Anatomic location of muscle loss. Am J Obstet Gynecol 2002; **186**:356-360.
34. Rud T, Andersson KE, Asmussen M, Hunting A, Ulmsten U: Factors maintaining the intraurethral pressure in women. Invest Urol 1980; **17**:343-347.
35. Boreham MK, Wai CY, Miller RT, Schaffer JI, Word RA: Morphometric analysis of smooth muscle in the anterior vaginal wall of women with pelvic organ prolapse. Am J Obstet Gynecol 2002; **187**: 56-63.
36. Lin SY, Tee YT, Ng SC, Chang H, Lin PP, Chen GD: Changes in the extracellular matrix in the anterior vagina of women with or without prolapse. Int Urogynecol J 2007; **18**:43-48.