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Reliability of pudendal nerve terminal motor latency

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Abstract. *Aim:* To evaluate reliability of Pudendal Nerve Terminal Motor Latency (PNTML). *Methods:* Forty healthy subjects, 24 women and 16 men, and eight female patients were included. Four patients had idiopathic faecal incontinence and 4 an anal sphincter rupture after childbirth. PNTML measurement was performed by two observers with the patient in left lateral and supine position. Examinations were repeated on another day to evaluate intraindividual reproducibility. *Results:* Interobserver reproducibility was 92%–116% for PNTML. Degree of agreement for PNTML between left lateral and supine position was 86%–111%. Intra-individual reproducibility in the supine and left lateral positions was 89%–109% and 88%–113% respectively. Normal values for mean PNTML were higher in women compared with men, 1.91 msec (2 SD, 0.52 msec) and 1.74 msec (2 SD, 0.33 msec) respectively, $t = 2.44$, 37 DF, $P<0.01$. *Conclusions:* Reliability of PNTML in terms of interobserver and intraindividual reproducibility was high. Women had higher normal values for PNTML than men.

Résumé. Le but du travail est d'étudier la fiabilité de la mesure du temps de latence du nerf honteux (PNTML). *Méthode:* Quarante sujets sains, 24 femmes et 16 hommes, ainsi que 8 patients de sexe féminin ont été inclus dans cette étude. Quatre patients souffrent d'incontinence fécale idiopathique et 4 présentent une rupture sphinctérienne aprés accouchement. La mesure du PNTML a été réalisée par deux observateurs avec le patient en décubitus latéral gauche et en décubitus dorsal. Les examens ont été refaits à 24 heures d'intervalle afin d'évaleur la reproductibilité de l'examen chez un même patient. *Résultat:* La reproductibilité entre observateurs est de 92 à 116% pour la mesure du PNTML. La corrélation pour la mesure du PNTML en position de décubitus latéral gauche ou en décubitus dorsal est de 86 à 111%. La reproductibilité chez un même individu en position dorsale ou en décubitus latéral est de respectivement de 89 à 109% et 86 à 113%. Les valeurs normales pour un PNTML moyen sont légèrement supérieures chez la femme que chez l'homme: 1,91 msec (2 SD, 0,52 msec) et 1,74 msec (2 SD, 0,33 msec), $t = 2,44$, 37 DF, $P<0.01$). *Conclusion:* La confidence de la mesure du PNTML est élevée en termes de reproductibilité inter-observateur et intra-individuelle. Les valeurs normales sont plus élévées chez la femme que l'homme.

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The external anal sphincter and the periurethral sphincter are innervated by the inferior rectal branches and perineal branches of the pudendal nerve [1]. Selective latencies from the two sphincters, after pudendal nerve stimulation, have been measured using the St. Marks Pudendal electrode [2, 3].

Motor latency is the time measured from stimulation of a motor nerve to the muscle response. It reflects the conduction velocity of the fastest conducting motor nerve fibers innervating the muscle and the neuromuscular synapse. Injury of the innervation of the pelvic floor may lead to urinary incontinence [2, 4], anal incontinence [5] or double incontinence [5, 6].

The St. Marks Pudendal Electrode was first introduced in the late 1980s and its reproducibility reported [7]. Data on interobserver reproducibility have however, only been reported once [8]. The aim of the present study was to evaluate interobserver and intraindividual reproducibility of Pudendal Nerve Terminal Motor Latency (PNTML) as well as establishing normal values for men and women in our laboratory.

Patients and methods

Forty healthy subjects, 24 women and 16 men, median age 41 years (range 21–72 years) participated. Eight of the women were nulliparous, 3 primiparous and 13 multiparous.

Eight female patients of whom 4 had idiopathic faecal incontinence and 4 anal sphincter rupture after childbirth of whom 2 had

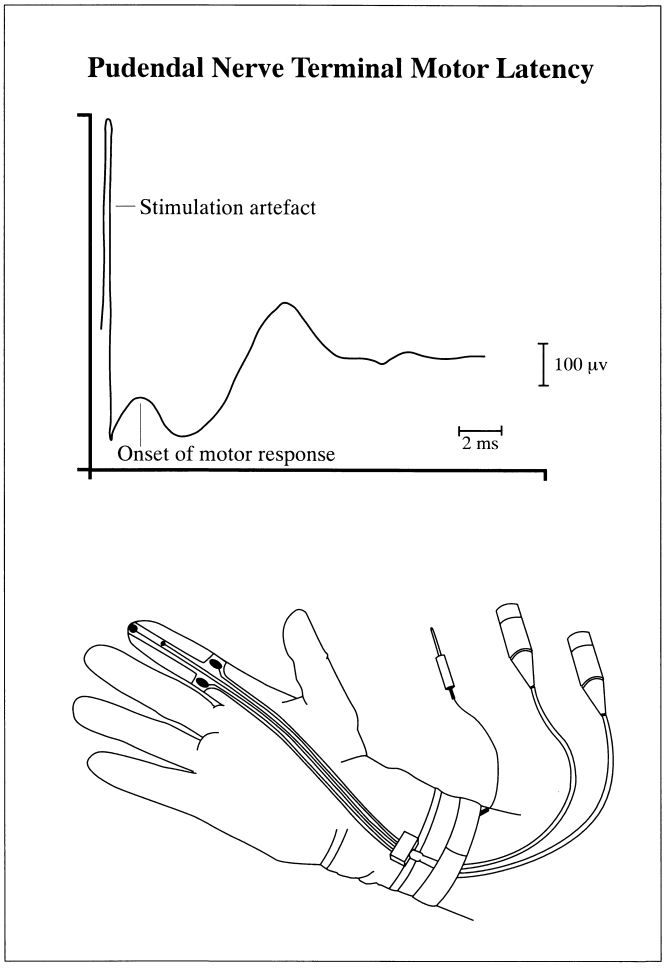

Fig. 1. *Top:* Prace of pudendal nerve stimulation (redrawn). *Bottom:* St. Marks pudendal electrode

faecal incontinence. Median age of the patients was 33 years (range 21–67 years). Normal subjects were recruited within the hospital staff, whereas patients were recruited at routine examination.

The electrode

Fig. 1 shows the electrode (Dantec, 13L40, Skovlunde, Denmark). It enables combined stimulation of the pudendal nerve and recording of anal sphincter electromyography (EMG). Stimulation is produced by the cathode. This is, only 2 mm in diameter and thus allows accurate stimulation. Anal sphincter EMG is measured between two semicircular pick-up plates at the base of the electrode.

Technique

A ground electrode was placed on the right thigh. Stimulation was performed with square wave stimuli of 0.1 millisecond duration, of 50 V (supramaximal stimulation) at 1 second intervals with a Neuromatic 2000 apparatus (Dantec, Skovlunde, Denmark). Filtre, settings was adjusted to 100 Hz (low-pass) and 10 kHz (high-pass).

Positioning of the electrode

With the subject in left lateral position with the hips and knees flexed, the electrode was mounted on the examiner's gloved index finger and inserted in the rectum. The ischial spine was palpated and stimulation of the pudendal nerve performed at this point. Contraction of the external anal sphincter was felt on stimulation of the pudendal nerve. The procedure was repeated on the contralateral side. Latency was measured from the onset of the stimulation artefact to the onset of motor response (Fig. 1).

The examination was repeated with the patient in the supine position with knees and hips flexed. A second investigator, who had not participated in the first examination, performed PNTML with the patient again in the left lateral position.

In eleven normal subjects and one patient the examination was repeated on another day up to one month later, with the patient in the left lateral and supine positions to evaluate the intra-individual reproducibility of the method. Table 1 shows a schematic flowchart of the study.

Table 1. Flowchart for measurement of PNTML

	Left lateral position	Supine position
Day 1		
Observer 1	X	X
Observer 2	X	
Day 2		
Observer 1	X	X
Observer 2	X	

····· Intraindividual reproducibility; ——— Interindividuel reproducibility; – – – – –Degree of agreement between left lateral and supine position

Definitions

Comparison between the two investigators was defined as interobserver reproducibility. Comparison of repeated investigations in the same patient by one investigator was defined as intra-individual reproducibility. Finally, comparison between investigation in left lateral and supine position was defined as degree of agreement.

Statistical methods

Data were plotted as differences of two examinations to the mean of the 2 examinations as proposed by Bland and Altman [9]. Reproducibility as well as degree of agreement was converted to percentages, where 100% represented total agreement between the two methods [10]. One-way analysis of variance was used for comparison between men and women. For further comparison between groups the two-sample t-test was used. The study was approved by the ethical committee of Copenhagen County. Written informed consent was obtained from all included in the study.

Results

The results for both observers are shown in Fig. 2. The plot of interobserver reproducibility for PNTML (mean value for right and left side) is shown in Fig. 3 a. No systematic variation was found. Plots of intraindividual reproducibility mean PNTML in the left lateral position for each observer are shown in Fig. 3 b and 3 c. No systematic variation was found. In the supine position, the intra-individual reproducibility is shown Fig. 3 d. No systematic difference was found. The degree of agreement for mean PNTML between left lateral and supine position is shown

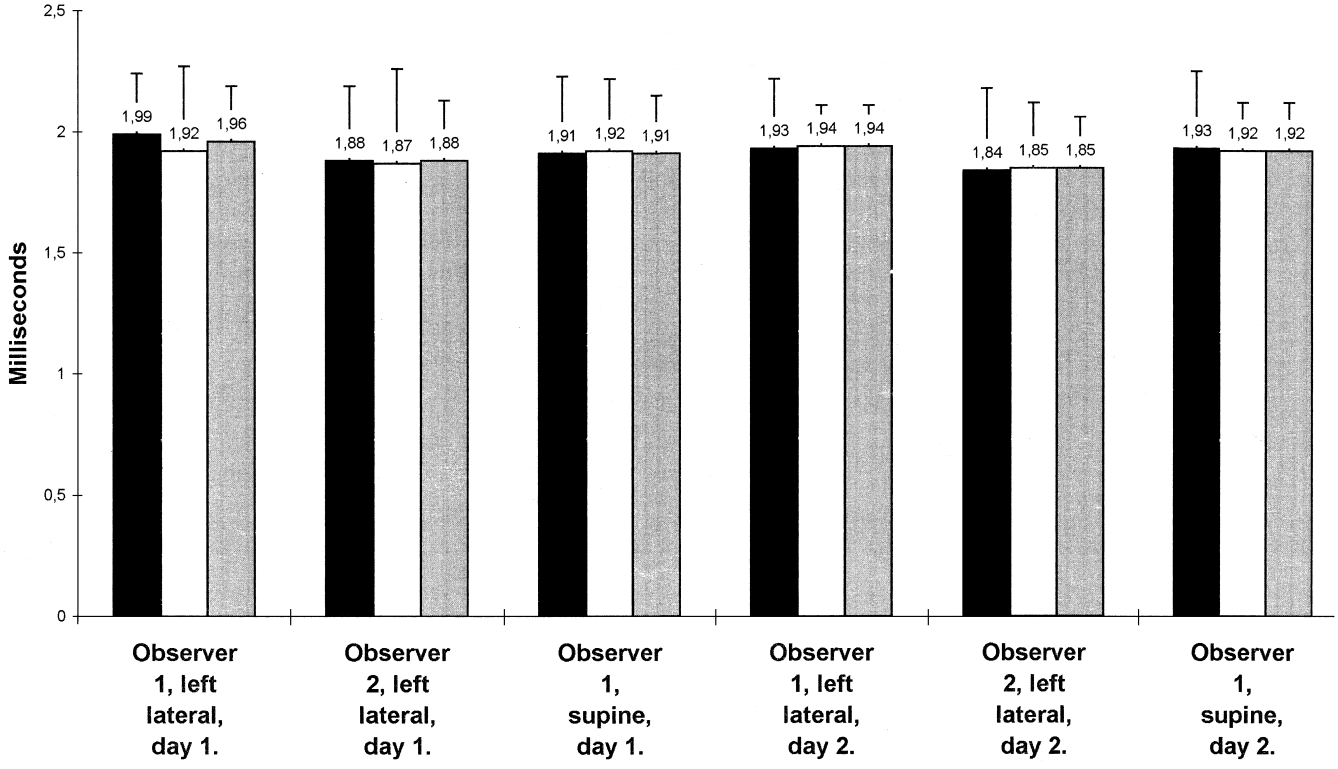

Fig. 2. Results of PNTML for both observers, day 1 and day 2 (mean with 2 SD). ■ Right, □ left, ▨ mean

Table 2. Reproducibility of PNTML (100% means total agreement)

	Right side [%]	Left side [%]	Mean of the two sides [%]
Interobserver ($n=17$)	86–127	81–128	92–116
Intraindividual			
Observer 1 ($n=12$)	91–117	81–116	88–113
Observer 2 ($n=11$)	81–113	81–121	91–113
Intraindividual, supine			
Observer 1 ($n=12$)	89–109	86–111	89–109
Supine vs. left lateral			
Observer 1 ($n=15$)	83–112	81–122	86–111

Table 3. PNTML in 40 healthy subject

	Mean PNTML, msec. (2 SD)
Women overall	1.91 (0.52)[a]
Nulliparous ($n=8$)	1.80 (0.48)
Primi/multiparous ($n=24$)	1.97 (0.52)[a]
Men	1.74 (0.33)

One-way analysis of variance showed difference between men, nulliparous and primi/multiparous, $F=4.53$, $P=0.017$. $P<0.01$, Compared to men (two sample t-test)

in Fig. 3e. No system variation was found. Reproducibility as well as degree of agreement expressed as percentages, including values for the separate sides, are summarized in Table 2. Normal values for PNTML in women were found to be higher than in men. Further analysis of the data showed that the difference was only present in parous women (Table 3).

Discussion

This study has shown that reproducibility for PNTML measured by two observers is good. Furthermore interobserver reproducibility is in the same range as intra-individual reproducibility. The examinations have been performed by two experienced investigators, which is necessary since the technique requires training to produce reliable results. Rogers et al. [7, 8] found interobserver reproducibility of 80% to 120%, similar to our own observations for both interobserver and intraindividual reproducibility which were within 90%–110%, particularly when the examination was performed in the supine position.

Intraindividual reproducibility was within 80%–120% for the other measurements. This confirms the findings of Rogers et al. [7] who at the introduction of the St. Marks pudendal electrode found an acceptable reproducibility.

While a reproducibility of 80%–120%, or ±20% day to day reproducibility may seem acceptable, but may contribute to the great overlap in PNTML between continent and incontinent patients [11].

Compared to the reproducibility of other anorectal physiological investigations, measurement of PNTML has a better reproducibility. Measurement of perineal descent

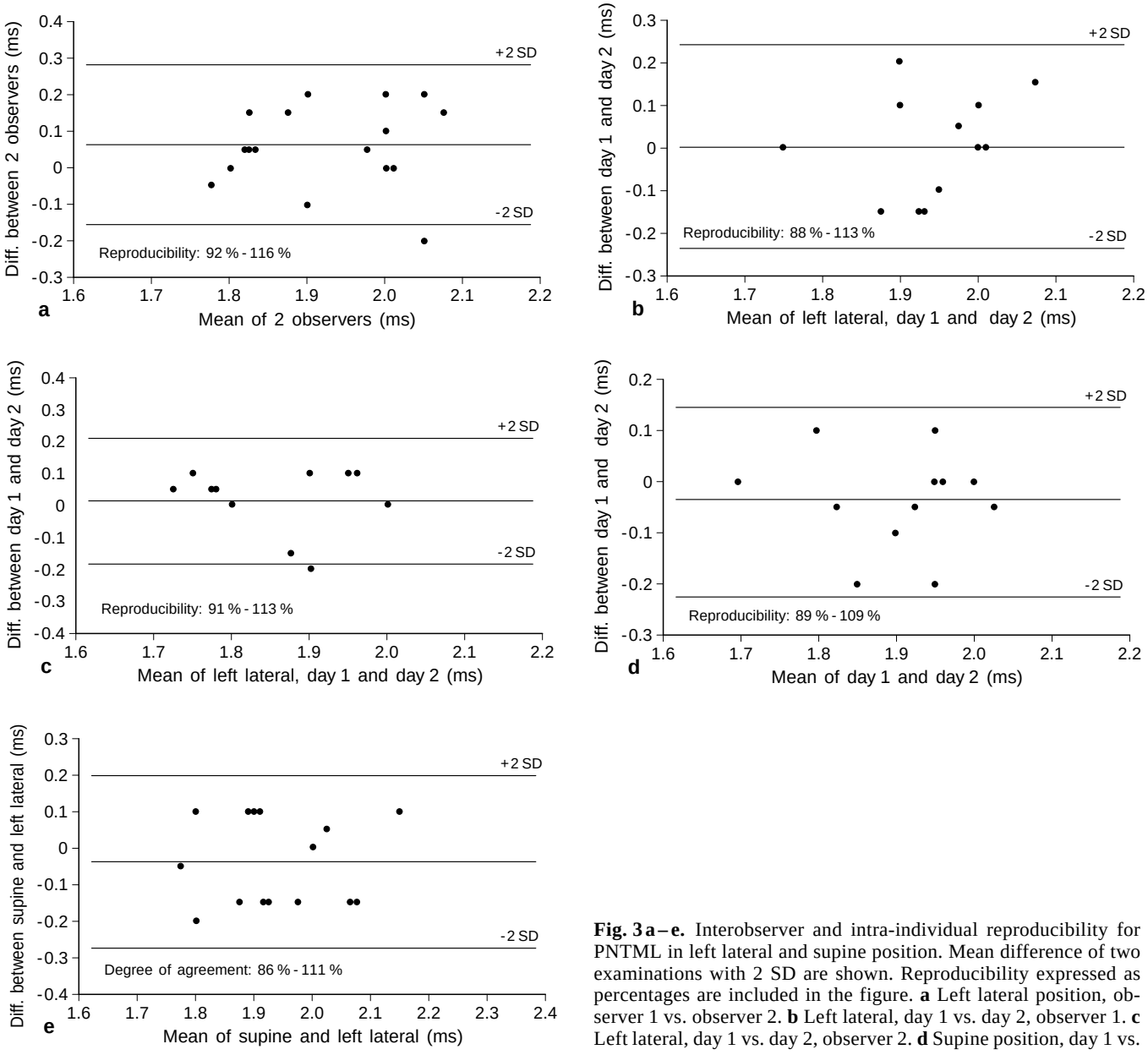

Fig. 3a–e. Interobserver and intra-individual reproducibility for PNTML in left lateral and supine position. Mean difference of two examinations with 2 SD are shown. Reproducibility expressed as percentages are included in the figure. **a** Left lateral position, observer 1 vs. observer 2. **b** Left lateral, day 1 vs. day 2, observer 1. **c** Left lateral, day 1 vs. day 2, observer 2. **d** Supine position, day 1 vs.

or rectal compliance has been reported to vary between 50% and 200% [8, 12].

Interobserver reproducibility of PNTML can partly be explained by the stimulation having being performed at different points from one examination to the next. Although the electrode has a fixed distance from the cathode to the pick-up plates, the pudendal nerve does not have a fixed distance in different individuals. It is thus likely that the latency will vary as a result. Another explanation of the variation may be that contact between the pick-up plates and the external anal sphincter is dependent on anal sphincter tone. In a relaxed patient one would expect a much better signal than in a tense patient. Our experience is that reliable signals are more difficult to achieve in patients with haemorrhoids or anal fissure.

Positioning of the patient was found to be important. Reproducibility seems to be better in the supine position, probably because the ischial spine and therefore the pudendal nerve is more easily palpated. Furthermore good contact between the electrode and the external anal sphincter is facilitated in this position, because interference from the gluteal muscles is less prominent.

In routine clinical practice we stimulate in the left lateral position, since most examinations are done in this position. However, when a poor signal or a doubtful latency is obtained, the examination is repeated in the supine position.

Differences between normal men and parous women were found, whereas there was no difference between men and nulliparous women. Childbirth has been associated with pudendal nerve damage [13] and may well explain the difference found in our study. In a study by Laurberg et al. [14], women over 50 years had higher PNTML than men of the same age, whereas this sex dif-

ference could not be found in younger men and women. In this study both men and women had higher PNTML than was found in the present study. This discrepancy may be explained by the selection of controls. We only included healthy subjects, whereas in the study of Laurberg et al. patients with minor colonic or rectal polyps were used as controls.

A normal value for the mean PNTML has been 2.0 msec (0.4 msec, 2 SD) and this value has been widely accepted. In a study of reproducibility of PNTML, it was suggested that data from different centers were comparable [8]. In our study, mean PNTML was nearly 0.2 msec lower in men compared with women. The same equipment was used in the two studies and we suggest that different centers establish their own normal values, especially since sex differences have to be taken into account in studies on pudendal nerve function.

References

1. Snooks SJ, Swash M (1985) Nerve stimulation techniques. In: Henry MM, Swash M (eds) Coloproctology and the pelvic floor. Butterworths, University Press, Cambridge, pp 112–117
2. Smith ALB, Honker G, Whirl D (1989) The role of pudendal nerve damage in the aetiology of genuine stress incontinence in women. Br J Obstet Gynecol 96: 29–32
3. Kiff ES, Swash M (1984) Normal and delayed conduction in the pudendal nerves of patients with idiopathic (neurogenic) faecal incontinence. J Neurol Neurosurg Psychiatry 47: 820–823
4. Smith ALB, Honker G, Whirl G (1989) The role of partial denervation of the pelvic floor in aetiology of genitourinary prolapse and stress incontinence of urine. A neurophysiological study. Gynecol 96: 24–28
5. Snooks SJ, Barnes PRH, Swash M (1984) Damage to the innervation of the voluntary anal and periurethral sphincter musculature in incontinence: an electrophysiological study. J Neurol Neurosurg Psychiatry 47: 1269–1273
6. Tetzschner T, Sørensen M, Christiansen J, Lose G (1996) Anal and/or urinary incontinence in women with obstetric anal sphincter rupture. Br J Obstet Gynaecol 103: 1034–1040
7. Rogers J, Henry MM, Miesewicz JJ (1988) Disposable pudendal nerve stimulator: evaluation of the standard instrument and a new device. Gut 29: 1131–1133
8. Rogers J, Laurberg S, Misiewicz JJ, Henry MM, Swash M (1989) Anorectal physiology validated: a repeatability study of the motor and sensory tests of anorectal function. Br J Surg 76: 607–609
9. Bland JM, Altman DG (1986) Statistical methods for assessing agreement between two methods of clinical measurement. Lancet I: 307–310
10. Murray GD, Miller R (1990) Statistical comparison of two methods of clinical measurement. Br J Surg 77: 384–387
11. Tetzschner T, Sørensen M, Rasmussen OØ, Lose G, Christiansen J (1995) Pudendal nerve damage increases the risk of faecal incontinence in women with anal sphincter rupture after childbirth. Acta Obstet Gynecol Scand 74: 434–440
12. Sørensen M, Rasmussen, OØ, Tetzschner T, Christiansen J (1992) Physiological agreement in rectal compliance. Br J Surg 92: 1106–1108
13. Sultan AH, Kamm MA, Hudson CN (1994) Pudendal nerve damage during labour: prospective study before and after childbirth. Br J Obstet Gynaecol 101: 22–28
14. Laurberg S, Swash M (1989) The effect of aging on anorectal sphincters and their innervation. Dis Colon Rectum 32: 737–742