[Frontiers in Bioscience 9, 159-163, January 1, 2004]

'OBJECTIVE' ASSESSMENT OF RECTAL SENSATION: A NOVEL APPROACH

Ahmed Shafik [1], Olfat El-Sibai [2], Ali A. Shafik [3], Ismail Ahmed [3]

[1] Department of Surgery and Experimental Research, Faculty of Medicine, Cairo University, Cairo, [2] Department of Surgery, Faculty of Medicine, Menoufia University, Shebin El-Kom, [3] Department of Surgery and Experimental Research, Faculty of Medicine, Cairo University, Cairo, Egypt

TABLE OF CONTENTS

1. ABSTRACT

Rectal sensation is used as an investigative tool in the diagnosis of anorectal pathology. However, the data obtained are subjective depending on the patient's perception of the sensation. We investigated the hypothesis that sympathetic skin response (SSR) can be used as a tool for objective assessment of the rectal sensation. The SSR was recorded in 24 healthy volunteers (age 37.2 years, 14 men) using a surface electrode applied to the skin of the palmar surface of the subject's hand and a reference electrode to the dorsum of the same hand. The EMG activity of the pelvic floor muscles was registered by a surface electrode fixed to the perineal skin. The subject was asked before and after individual anesthetization of the rectum and palm to report the first rectal and urge sensations during balloon filling of the rectum in increments of 10 ml of saline. Low volume rectal distension effected no sympathetic skin or pelvic floor responses, while larger volumes produced the response. The skin and pelvic floor responses occurred with every rectal sensation and corresponded with the volunteers' subjective perception. Urge suppression was associated with synchronous decrease of skin and pelvic floor responses which disappeared on balloon expulsion. Rectal balloon distension, 20 minutes after individual anesthetization of the rectum or palm produced no palm skin response, which returned however 3 hours later. A novel approach which can objectively define subjective perceptions arising from the rectum has been identified. Rectal sensations produce coordinated sympathetic skin response and pelvic floor activity which seem to be mediated through a reflex which we term the "recto-palmar reflex". Further studies are required to investigate the role of this reflex in defection and sympathetic disorders.

2. INTRODUCTION

During rectal filling, the subject perceives 2 sensations: the first rectal sensation and then the urge sensation (1,2). At urge, the subject either defecates or voluntarily controls the urge sensation when defecation is inopportune. The conscious perception of these sensations seems necessary for fecal control (3-5). Pathological changes in rectal sensation commonly lead to changes in rectal function such as fecal incontinence (6-11). Rectal sensation can be recorded during routine performance of anorectal dynamic studies (3,4). However the data obtained are subjective and depending on the patient's perception of the sensation. For this reason, objective criteria for the evaluation of rectal sensation are required.

The sympathetic skin response is a technique that records changes in skin conductance. In this procedure the sweat glands in skin areas rich in eccrine glands such as the palmar and plantar surfaces, which are under the neural control of sympathetic cholinergic sudomotor fibers, are activated (12). The sympathetic skin response depends on the integrity of peripheral sympathetic cholinergic pathways and is used for studying peripheral sympathetic neuropathy (13). In this communication, we investigated the hypothesis that sympathic skin response can serve as a tool for objective assessment of rectal sensation.

3. MATERIAL and METHODS

3.1. Subjects

Twenty four healthy volunteers were enrolled in the study after giving an informed consent Fourteen were men and 10 women with a mean age of 37.2±10.8 SD years (range 26–48). The subjects had no history of diabetes or neurologic disease. They were on no medication. Subjects being on medications that would affect the nervous system were excluded from the study.

Physical examination including neurologic assessment had normal findings. The reflexes were also normal. Laboratory work-up was unremarkable. The study was approved by our Cairo University Faculty of Medicine Review Board and Ethics Committee.

3.2. Methods

3.2.1. Sympathetic skin response recording

The sympathetic skin responses were recorded by means of a surface electrode (Smith Kline-Beckman, Los Angeles, CA, USA) applied to the skin of the palmar surface of the right hand and reference electrode to the dorsum of the same hand; the sampling rate was 5000 Hz and the band pass was 0.5 to 2000 Hz.

3.2.2. Electrogmyographic recording of the pelvic floor muscles activity

The EMG activity of the pelvic floor muscles was recorded by means of a surface electrode (Smith Kline-Beckman, Los Angles, CA, USA) applied to the perineal skin. A standard electromyographic apparatus (type MES. Medelec, Woking, UK) was used to amplify and display the potentials obtained. The amplifier (type AA6 MKIM, Medelec, Woking, UK) was set with a low-frequency filter at 16 Hz and a high-frequency filter at 3200 Hz. Films of the potentials were taken on light-sensitive paper (Linagraph type 1895, Kodak) from which measurements of motor unit action potentials duration were made. The EMG signals were also stored on an FM tape recorder (type 7758 A, Hewlett Packard, Waltham, MA, USA) for further analysis as required.

3.2.3. Balloon filling of the rectum

The subject was instructed to fast for 8 hours prior to the test and the bowel was evacuated by saline enema. The rectum was distended by means of a thin polyethylene infinitely complaint balloon of 3 cm in diameter which was attached to the end of a 10 F tube (London Rubber Industries Ltd., London, UK). With the subject lying in the left lateral position and under no medication, the collapsed balloon was introduced per anum to lie in the rectum at a distance of 8 –10 cm from the anal orifice. The tube was connected to a strain gauge pressure transducer (Statham P, 23bb, Oxnard, CA, USA). Before starting the test, the balloon in the rectum was allowed a 20-minute period for gut adaptation. It was then filled with normal saline in increments of 10 ml.

During performance of the test certain precautions were taken to protect the subject from factors that could affect the sympathetic skin response. The room in which the tests were performed had an ambient temperature of between 22 and 24 ºC, and was free of noise and bright light. The subject was instructed to close the eyes and report on 2 perceptions during rectal balloon filling: the first rectal sensation and the urge to evacuate. At the point of urge sensation, the subject was asked to voluntarily contract the pelvic floor muscle for 20 to 30 s. Rectal balloon filling was then continued until the balloon was dispelled to the outside.

3.2.4. Anesthetization of the rectum and the palm

In order to verify the constancy of the relationship between rectal balloon distension and palmar skin response and to investigate whether or not the response is reflex in nature, the rectum in 14 subjects, who were randomly selected from the 24 volunteers, was anesthetized by rectal instillation of 20 ml of lidocaine diluted with 30 ml of normal saline. The palmar skin response to rectal balloon distension was then assessed after 20 minutes and again after 3 hours when the anesthetic effect had disappeared. The procedure was repeated using normal saline instead of xylocaine.

On a different day, the palmar skin was anesthetized using 5% Emla cream (Lidocaine + Prilocaine, Astra, Södertälje, Sweden). The palmar skin response to rectal balloon distension was tested 20 minutes later and again after 3 hours. The procedure was repeated using bland cream.

To assess reproducibility of the results, at least two recordings were made in the individual subject and the mean value was calculated. The results were analyzed statistically by means of the Student's t test. Differences assumed significance at $p<0.05$, and values were given as the mean ± standard deviation (SD).

4. RESULTS and DISCUSSION

The tests were completed in all the subjects with no adverse side effects during or after performance of the tests. Rectal balloon distension with low volumes of 10 and 20 ml effected neither changes in the sympathetic skin activity nor pelvic floor responses ($p>0.05$). The first rectal sensation which occurred at a mean rectal balloon distension of 32.6±3.8 ml (range 30–40) evoked sympathetic skin responses which were associated with pelvic floor contractions (Figure 1). The skin and pelvic floor responses occurred with every rectal sensation and corresponded with the volunteers' subjective perception; they lasted for a mean of 3.6±1.2s (range 1.8– 6.3) and had a mean latency of 1.72s (range 1.33–1.95).

With increasing rectal balloon filling, the occurrence of the skin and pelvic floor responses as well as of the rectal sensation increased (Figure 2). When rectal balloon filling was continuously increased until the subject reported the urge to defecate, frequent sympathetic skin responses associated with pelvic floor contraction were registered (Figure 3).

During the period of opposing the urge by voluntary contraction of the pelvic floor muscles, the

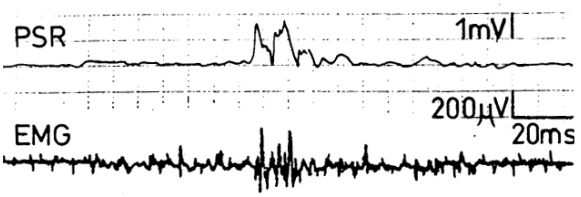

Figure 1. The palm (sympathetic) skin response (PSR) and pelvic floor muscle activity synchronous with first rectal sensation. EMG = Electromyography

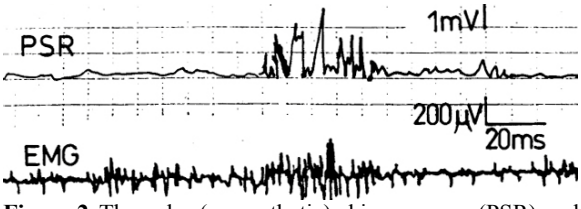

Figure 2. The palm (sympathetic) skin response (PSR) and pelvic floor muscle activity synchronous with increased rectal filling to volumes above that of first rectal sensation. EMG = Electromyography

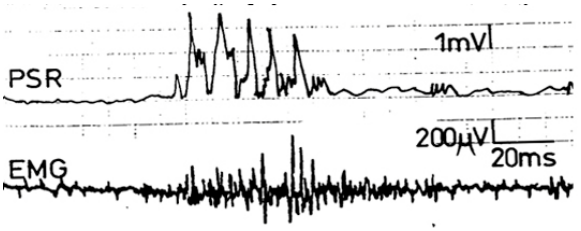

Figure 3. The palm (sympathetic) skin response (PSR) and pelvic floor muscle activity synchronous with urge sensation. EMG = Electromyography

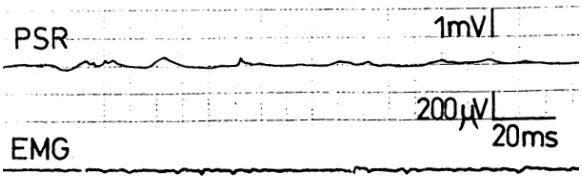

Figure 4. The palm (sympathetic) skin response (PSR) and pelvic floor muscle activity during voiding; both responses disappeared. EMG = Electromyography

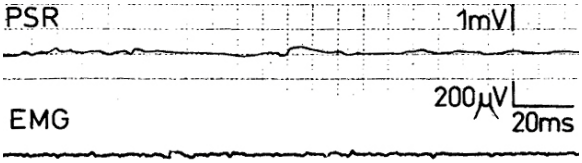

Figure 5. The palm (sympathetic) skin response (PSR) and pelvic floor muscle activity 20 minutes after rectal anesthetization. EMG = Electromyography

subject's report of decrease in the urge sensation was associated with synchronous decrease of the palmar sympathetic skin responses. When after some time the subject reported the return of the urge sensation, the sympathetic skin reaction and pelvic floor muscles' response showed synchronous increase. However the waning of the urge sensation occurring with expulsion of the balloon to the exterior was associated with disappearance of the sympathetic skin response and relaxation of the pelvic floor muscles (Figure 4).

4.1. The effect of rectal distension on palmar skin response after individual anesthetization of rectum and palmar skin

Rectal balloon distension 20 minutes after individual anesthetization of the rectum or the palm produced no palmar skin response (Figure 5). When the anesthetic effect had waned 3 hours after anesthetization, rectal balloon distension produced palm skin response similar to that before anesthetization. When we repeated the test instilling normal saline into the rectum instead of lidocaine and applying bland cream to the palm skin instead of Emla cream, the palmar skin response was similar to that before saline or cream application.

Results were reproducible with no significant difference when the test was repeated in the same individual.

The current study identifies a novel approach to objective definition of subjective perceptions arising from the rectum. This was achieved by evaluating recordings of the palmar skin response and pelvic floor electromyography. During rectal filling, rectometry (14) shows no significant rectal changes in the early filling stage, due presumably to rectal adaptation. As filling continues and rectal pressure elevates, the rectal mechanoreceptors seem to be activated and the first rectal sensation is perceived. Added rectal filling and mechanoreceptors' activation further elevate the rectal pressure and evoke the urge sensation which is followed by balloon expulsion to the exterior(14). Although the first rectal and the urge sensation are marked on the rectometry charts, yet the recording of those marks is purely subjective. Commonly, the subjects reported the first rectal sensation as a weak sensation while they felt the 2nd rectal sensation as urging sensation. The first rectal sensation was recorded during rectometric studies at a mean of 35.2±5.6% of the maximum rectometric capacity, while the urge occurred at 81.2±8.7%[14]. In the current study, palmar sympathetic skin response and pelvic floor contraction were reported at the first rectal sensation. The skin response and pelvic floor contraction increased progressively with increase in the rectal filling, reaching their peak at urge and just before balloon expulsion to the exterior. Balloon expulsion was associated with waning of the urge sensation, disappearance of the sympathetic skin response and pelvic floor relaxation. Pelvic floor muscle contraction during rectal balloon filling and its increase with more rectal filling could be considered as a guarding action tending to inhibit rectal contraction, an action mediated through the voluntary urinary inhibition reflex (15).

4.2. Rectal-sympathetic skin response pathway

Upon rectal filling, tension receptors in the rectal wall are stimulated and impulses are transmitted by means of A $\propto$ and C-fibers (16,17). The afferent fibers transmit the rectal impulses via the pelvic, hypogastric, and

pudendal nerves to the lumbar and sacral segments of the spinal cord (16-18). At high filling levels, the spinal pathway seems to be transferred to a supraspinal one (17,18). The **sudomotor** pathways controlling the sweat glands are assumed to be generated by supraspinal descending pathways located at the brain stem, hypothalamus and higher structures (19). A sympathetic skin response related to perceptions arising from the rectum is suggested to be evoked by a similar pathway.

The simultaneous sympathetic (autonomous) skin and somatic pelvic floor responses to rectal sensation seem to denote coordinated action of the somatic and sympathetic pathways. This coordination appears necessary for proper rectal sensations and function; impaired coordination may lead to defecation disorders.

4.3. The recto-palmar reflex

The current study postulates a reflex relationship between rectal distension and sympathetic skin responses as represented by the palm. This reflex relationship is verified by reproducibility and by its absence during individual anesthetization of the assumed 2 arms of the reflex arc, namely the rectum and the palm skin. Lidocaine anesthetization blocks sensory C and A $\propto$ fibers which are responsible for pain and reflex activity (20). We term this reflex relationship the "recto-palmar reflex" and suggest that it is evoked by stimulating the sensory nerve endings in the rectal mucosa.

4.4. Diagnostic role of the recto-palmar reflex

The pelvic and hypogastric plexuses as well as the pudendal nerves presumably transmit the rectal impulses to the sacral and lumbar segments of the spinal cord (16-18) from where the signals are transmitted to the cerebrum. The recto-palmar reflex, besides providing objective data regarding the rectal sensations, may prove to be of diagnostic significance not only in rectal but also in sympathetic disorders. Detectable changes in the amplitude of the evoked response is likely to indicate a defect in the reflex pathway. In further studies, the reflex may test to be a valuable tool in the investigation of the patients with anorectal or sympathetic disorders.

In conclusion, the current study presented a novel approach to objectively define subjective perceptions arising from the rectum. Rectal sensations produce coordinated sympathetic skin response and pelvic floor activity which denote combined activation of both the somatic and sympathetic pathways; this coordination appears to be necessary for normal rectal function. The sympathetic skin and pelvic floor responses to rectal filling seem to be mediated through a reflex called the recto-palmar reflex. Further studies are required to investigate the role of this reflex in defecation and sympathetic disorders.

5. ACKNOWLEDGMENT

Margot Yehia assisted in preparing the manuscript.

6. REFERENCES

1. Wexner, S.D. & R. Gilliland: Setting up a colorectal physiology laboratory. In: Colon & Rectal Surgery. Ed: Corman M.L. 4th edn. Philadelphia, Lippincott-Raven, USA.106-140 (1998)
2. Solana, A., J.V. Roig, C. Villoslada, J. Hinojosa & S. Lledo: Anorectal sensitivity in patients with obstructive defecation. *Int J Colorect Dis* 11, 65-70 (1996)
3. Meagher, A.P., M.L. Kennedy & D.Z. Lubowski: Rectal mucosal electrosensitivity - what is being tested? *Int J Colorect Dis* 11, 29-33 (1996)
4. Roe, A.M., D.C. Bartolo & N.J. Mortensen: New method for assessment of anal sensation in various anorectal disorders. *Br J Surg* 73, 310-312 (1986)
5. Duthie, H.L. & F.W. Gairns: Sensory nerves and sensation in the anal region of man. *Br J Surg* 47, 585-595 (1960)
6. Wald, A. & A.K. Tunuguntla: Anorectal sensorimotor dysfunction in fecal incontinence and diabetes mellitus: modification with biofeedback therapy. *N Engl J Med* 310, 1282–1285 (1984)
7. Leighton, J.A, M.A. Valdovinos, J.H. Pemberton, D.M. Roth & M. Camilleri: Anorectal dysfunction and rectal prolapse in progressive systemic sclerosis. *Dis Colon Rectum* 36, 182-185 (1993)
8. Jacobs, P.P.M, M. Scheuer, J.H.C Kuijpers & M.H Vingerhoets: Obstetric fecal incontinence: Role of pelvic floor denervation and results of delayed sphincter repair. *Dis Colon Rectum* 33, 494-497 (1990)
9. Rogers, J., M.M. Henry & J.J Misiewicz: Combined sensory and motor deficit in primary neuropathic fecal incontinence. *Gut* 29, 5-9 (1988)
10. Miller, R., D.C.C. Bartolo, F. Cervero & N.J. Mortensen: Anorectal sampling: A comparison of normal and incontinent patients. *Br J Surg* 75, 44-47 (1988)
11. Sun, W.M., N.W. Read & P.B. Miner: Relation between rectal sensation and anal function in normal subjects and patients with fecal incontinence. *Gut* 31, 1056-1061 (1990)
12. Shahani, B.T, J.J Halperin, P. Boulu & J. Cohen: Sympathetic skin response- a method for assessing unmyelinated axon dysfunction in peripheral neuropathies *J Neurol Neurosurg Pschiatry* 74, 536-542 (1984)
13. Gutrecht J.A: Sympaythetic skin response. *J Clin Neurophysiol* 11, 519-524 (1994)
14. Shafik A. & K.A. Moneim: Rectometry. A new method assessing rectal function. *Coloproctology* 13, 237-243 (1991)
15. Shafik A. & O. El-Sibai: Rectal inhibition by inferior rectal nerve stimulation in dogs: recognition of a new reflex: The voluntary anorectal inhibition reflex. *Eur J Gastroenterol Hepatol* 13, 413-418 (2001)
16. Morgan C, I. Nadelhaft & W.C. de Groat: The distribution of visceral primary afferents from the pelvic nerve to Lissauer's tract and the spinal gray matter and its relation to the sacral parasympathetic nucleus. *J Com Neurol* 201, 415-440 (1981)
17. De Groat WC, I. Nadelhaft, R.J. Milne, A.M. Booth & C. Morgan. Organization of the sacral parasympathetic reflex pathways to the urinary bladder and large intestine. *J Auton Nerv Syst* 3, 135-160 (1981)

18. Habler HJ, K. Hilbers, W. Janig, M. Koltzenburg, H. Kummel, N. Lobenburg-Khosravi & M. Michaelis: Viscero-sympathetic reflex responses to mechanical stimulation of pelvic viscera in the cat. *J Auton Nerv Syst* 38, 147-158 (1992)
19. Langworthy O.R., C.P. Richter: The influence of efferent cerebral pathways upon the sympathetic nervous system. *Brain* 53, 178-189 (1930)
20. Yokoyama O, K. Komotso, K. Kodama, S. Yotsuyanagi, S. Niikura & M. Namaiki: Diagnostic value of intravesical lidocaine for overactive bladder. *J Urol* 164, 340-343 (2002)

Key words: Sympathetic Skin, Pelvic Floor, Palm, Urge Sensations, Subjective Perception, Reflex, Rectum

Send correspondence to: Ahmed Shafik, MD, PhD, 2 Talaat Harb Street, Cairo 11121, Egypt, Tel/Fax: +20-2-7498851, E-mail: shafik@ahmed-shafik.org, URL: www.ahmed-shafik.org