# Puborectalis muscle and External Anal Sphincter: a functional unit?

**Nikolaos Andromanakos[1], Dimitrios Filippou[2], Nikolaos Karandreas[3], Alkiviadis Kostakis[4]**

[1]Department of General Surgery, Athens General Hospital "Evagelismos-Athens Eye Hospital-Polykliniki", Athens, Greece
[2]Department of Anatomy and Surgical Anatomy, Athens University Medical School, Athens, Greece
[3]First Department of Neurology, Athens University Medical School, Hospital "Eginitio", Athens, Greece
[4]Biomedical Research Foundation of Athens Academy, Athens, Greece

**Cite this article as:** *Andromanakos N, Filippou D, Karandreas N, Kostakis A. Puborectalis muscle and External Anal Sphincter: a functional unit? Turk J Gastroenterol 2020; 31(4): 342-3.*

Dear Editor,

As is already known, the pelvic floor is formed by muscles, ligaments, and fasciae that occlude the outlet of the pelvis, leaving a hollow for the pelvic organs (rectum, vagina, and urethra) to pass into the perineum. Levator ani is the most important muscle of the pelvic floor that not only supports the pelvic organs but also regulates anorectal physiology and the function of urogenital organs and consists of four muscle components, i.e., puborectalis, pubococcygeus, iliococcygeus, and coccygeus. The puborectalis and anal sphincters are in a unique state of continuous tonic activity that changes in response to different stimuli and conditions (rectal distension and increase of intra-abdominal pressure) to facilitate defecation or to prevent leaking of enteric content (1). Wendell-Smith suggested that the puborectalis muscle along with the external anal sphincter constitute a functional unit that shares innervation and action (2). Thereinafter, the concept of a functional unit formed by the puborectalis and external anal sphincter muscles has been a challenge for several studies that focused in their innervation, which is still obscure. However, a synergistic function and activity between these muscles may facilitate the pelvic floor's complex role in continence and defecation.

An important study of the pelvic floor's neuroanatomy and neurophysiology suggested that levator ani is innervated by many branches of the $S_2$-$S_4$ sacral nerves, while the external anal sphincter is innervated by neural fibers of the pudendal nerve that originates mainly from the $S_2$ sacral nerve but may vary among people until the S4 sacral nerve ($S_2$-$S_4$). Documentation of the functional significance of the anatomical findings was carried out by stimulation of the sacral nerves and the pudendal nerve at various levels. Stimulation of the sacral nerves caused a puborectalis contraction and decrease of the anorectal angle. Stimulation of the pudendal nerve caused a contraction of the external anal sphincter and increase of anal canal pressure but not a contraction of the puborectalis muscle (3). These findings agree with those of the electrophysiological studies conducted by several authors, which suggest different innervation for the puborectalis muscle and external anal sphincter (4). Thus, theories that support the differences in innervations of these muscles are confirmed, although their motor nerves originate from the same parts of the spinal cord. Wendell-Smith reported that the innervation of the pelvic floor muscles and the sphincters is related to their embryological origin. The muscles, which come from the sphincter cloacae, receive innervation from the pudendal nerve, and the distal muscles of the pelvis (pelvicaudal muscles) receive innervation from the sacral nerves (2). During pelvic floor repair, the external anal sphincter is easily separated from the levator ani using neuromuscular stimulation, which contracts the external anal sphincter and ensures its identification. Stimulation above the assumed level of separation causes a contraction of the puborectalis muscle but not of the external anal sphincter. In favour of the above mentioned studies is the possible presence of an anatomical level of separation between the external anal sphincter and the puborectalis muscle, which is noted at an embryonic level among the muscles with a pelvic origin and cloacal origin (5). However, another study suggested that the puborectalis muscle may be innervated in its pelvic surface by branches of the pelvic nerves and in its perineal surface by branches of the pudendal nerve, while a third innervation of the levator ani may arise from the pudendal nerve (6, 7). This raises the question, why does pudendal nerve stimulation produce a contraction of only the external

*Corresponding Author:* ***Nikolaos Andromanakos; n.andromanakos@gmail.com***
*Received:* ***March 21, 2019*** *Accepted:* ***May 22, 2019***

*DOI:* ***10.5152/tjg.2020.19208***

anal sphincter and not of the puborectalis muscle? In addition, on digital transanal examination of the puborectalis muscle, a paradoxical event is observed. Upon voluntary contraction of the anal sphincter muscle, a simultaneous puborectalis contraction is perceived by the examiner's finger. If the puborectalis muscle and external anal sphincter form a functional unit, is the puborectalis a voluntary muscle such as the external anal sphincter? Electrophysiological studies fail to explain the functional unit between the puborectalis and external anal sphincter muscles, and this could be due to the close anatomical relation. This close relation of their anatomy is suggested in a study by Shafik (8), which states that stimulation of the external anal sphincter is followed by an instantaneous mass contraction together with the external urethral sphincter, bulbocavernosus muscle and the puborectalis muscle (levator ani). Similarly, stimulation of any of these muscles also leads to their mass contraction (8). This is a phenomenon that also occurs during the voluntary contraction of the anal sphincter muscles that probably originates in close anatomical relation of the pelvic floor muscles. Morever, the observed relaxation of the puborectalis muscle and the external anal sphincter during defecation, while the pubococcygeus muscle is simultaneously contracted, indicates that the puborectalis function is synergic with that of the external anal sphincter and at the same time different from that of the pubococcygeus muscle (levator ani).

In conclusion, although the puborectalis and external anal sphincter muscles seem to have different innervations, the concept of a functional unit of these muscles is proposed due to their close anatomic relation. Given that the synergistic action of the above mentioned muscles defines the most important physiology of the anorectum and pelvic floor, accurate knowledge of their innervation may significantly contribute to the management of dysfunctional perineal syndromes.

***Peer-review:*** Externally peer-reviewed.

***Author Contributions:*** Concept – N.A., D.F., N.K., A.K.; Design - N.A., D.F., N.K., A.K.; Supervision - N.A., D.F., N.K., A.K.; Resource - N.A., D.F., N.K., A.K.; Materials - N.A., D.F., N.K., A.K.; Data Collection and/or Processing - N.A., D.F., N.K., A.K.; Analysis and/or Interpretation - N.A., D.F., N.K., A.K.; Literature Search - N.A., D.F., N.K., A.K.; Writing - N.A., D.F., N.K., A.K.; Critical Reviews - N.A., D.F., N.K., A.K.

***Conflict of Interest:*** The authors have no conflict of interest to declare.

***Financial Disclosure:*** The authors declared that this study has received no financial support.

## *REFERENCES*

*1. Raizada V, Mittal RK. Pelvic floor anatomy and applied physiology. Gastroenterol Clin North Am 2008; 37: 493-509.* [Crossref]
*2. Wendell-Smith CP. Studies on the morphology of the pelvic floor. PhD. Thesis, University of London, 1967.*
*3. Matzel KE, Schmidt RA, Tanagho EA. Neuroanatomy of the striated muscles anal continence mechanism: implications for the use of neurostimulation. Dis Colon Rectum 1990; 33: 666-73.* [Crossref]
*4. Eickmeyer SM. Anatomy and Physiology of the Pelvic Floor. Phys Med Rehabil Clin N Am 2017; 28: 455-460.* [Crossref]
*5. Levi AC, Borghi F, Garavoglia M. Development of the anal canal muscles. Dis Colon Rectum 1991; 34: 262-6.* [Crossref]
*6. Sagar PM, Pemberton JH. Anorectal and pelvic floor function: Relevance to continence, incontinence and constipation. Gastroenterol Clin North Am 1996; 25: 163-82.* [Crossref]
*7. Guaderrama NM, Liu J, Nager CW, et al. Evidence for the innervation of pelvic floor muscles by the pudendal nerve. Obstet Gynecol 2005; 106: 774-81.* [Crossref]
*8. Shafik A. A new concept of the anatomy of the anal sphincter mechanism and the physiology of defecation: mass contraction of the pelvic floor muscles. Int Urogynecol J Pelvic Floor Dysfunct 1998; 9: 28-32.* [Crossref]