Research Article

Journal of Surgery and Surgical Procedures

Visceral Sensitivity and Perceptual Thresholds in Colostomy: A Neurophysiological and Engineering Review

Claudio Bencini*, MD, FICS, FBHS

Medicea Medica Research Division, Livorno, Italy

***Corresponding author**

Claudio Bencini, MD, FICS, FBHS
Medicea Medica Research Division, Livorno, Italy.

Submitted : 27 Oct 2025 ; Published : 15 Nov 2025

Citation: Bencini, C. (2025). Visceral Sensitivity and Perceptual Thresholds in Colostomy: A Neurophysiological and Engineering Review. *J Sur & Surgic Proce.*,*3*(4):1-3.

Abstract

Background: *Visceral perception arises from mechano-afferent networks modulated by cortical feedback. Colostomy disrupts this loop, yet residual sensory activity may persist.*

Objective: *To integrate neurophysiological and biomechanical data relevant to colostomy and to outline a theoretical model for adaptive continence devices.*

Methods: *A structured narrative review (PubMed, Scopus, IEEE Xplore 1980–2025) identified 28 studies on rectal sensitivity, cortical plasticity after diversion, and gut biomechanics. Recent evidence on neural remapping (Luo et al., 2022; Carvalho et al., 2023) was incorporated. Quantitative ranges were extracted and translated into engineering parameters.*

Results: *Mean first-sensation threshold = 25 ± 5 mm Hg; pain threshold > 50 mm Hg. fMRI after diversion shows partial cortical re-organisation with preserved interoceptive mapping. A theoretical stress-transfer model (Eq. 1) links peristomal tension (σ_s) to rectal wall stress (σ_r).*

Conclusion: *Although direct measurements in stoma tissue are lacking, theoretical analogies supported by known mechanics offer a safe design framework. Ethical neutrality and transparent conflict declarations ensure scientific integrity.*

Introduction

Loss of rectal sensory feedback after colostomy profoundly modifies brain–gut signalling (Camilleri & Coulie, 2006; Brock et al., 2009). While early studies established reproducible barostat thresholds (Corsetti et al., 2004; Shafik & El-Sibai, 1999; Ford et al., 1995; Bouin et al., 2002), few addressed how altered afference might guide restorative technologies. This review re-examines evidence on visceral sensitivity and interprets it within an engineering framework for safe device design.

Methods

Electronic databases (PubMed, Scopus, IEEE Xplore) were searched in February 2025 using combinations of keywords: *visceral sensitivity, rectal distension, colostomy, mechanoreceptor, barostat, biomechanics.*

Reference lists of retrieved articles were manually screened. Only peer-reviewed human or validated animal models with quantitative outcomes were included.

Grey literature and promotional reports were excluded.

Data extraction captured sample size, stimulus method, pressure units, sensory thresholds, and conclusions.

Results were narratively synthesised due to heterogeneity.

Neurophysiological Background

Rectal and sigmoid walls contain intraganglionic laminar endings and stretch-sensitive mucosal receptors transmitting via pelvic nerves to spinal and cortical centres (Camilleri & Coulie, 2006; Holzer, 2011).

Perceptual thresholds measured by barostat average ≈ 25 mm Hg for first sensation, ≈ 40 mm Hg for urge, > 50 mm Hg for pain (Corsetti et al., 2004; Shafik & El-Sibai, 1999; Ford et al., 1995).

Wall tension (Laplace's law) is the main determinant (Bouin et al., 2002).

The integration of Meissner's and Auerbach's plexuses mediates adaptive relaxation that prevents excessive strain.

Sensory Loss after Colostomy

Following diversion, cortical mapping reorganises: somatosensory evoked potentials after anal stimulation are reduced but not abolished (Akervall et al., 1989; Kald et al., 2002; Karadağ et al., 2005).

fMRI studies reveal attenuated activation of insular and cingulate areas (Kald et al., 2002).

Clinically, patients describe diffuse abdominal awareness without urge (Laucks, 1988).

These findings indicate partial deafferentation with retained submucosal excitability when the rectal cuff is preserved.

Balloon-Distension and Perceptual Thresholds

The standard barostat protocol inflates latex balloons in 4 mm Hg steps, recording first perception, urge, and pain (Tillisch et al., 2021; Labus et al., 2022).

Normal subjects perceive distension at 20–30 mm Hg (27–40 cm H_2O); discomfort arises above 50 mm Hg (Mahawongkajit et al., 2024).

In colostomy remnants, sensitivity depends on preserved rectal length (Abbas et al., 2022).

Early experiments by Bencini et al. (1986) showed re-elicitable sensory perception with graded balloon inflation, supporting afferent viability (Giannios et al., 2019).

Engineering Implications

Mechanosensory data guide design parameters for adaptive continence plugs.

Sensors should maintain wall tension ≤ 30 mm Hg to remain within comfort range (Kvietys & Granger, 1982; Chou et al., 1990).

Finite-element simulations confirm strain localisation near mucosal folds rather than uniform pressure fields (Chou et al., 1990).

Device control algorithms can exploit cyclical inflation below ischemic thresholds (≤ 50 mm Hg) (Mayer et al., 2023).

Equation 1 – Theoretical stress equivalence model

$$\boldsymbol{\sigma_s = k \cdot \sigma_r \cdot (t_r / t_s)}$$

where σ_s = peristomal wall stress,
σ_r = rectal reference stress (≈ 25 mm Hg, extrapolated from rectal sensory thresholds),
t_r = rectal wall thickness,
t_s = stomal dermal-subcutaneous thickness,
k = empirical coefficient (0.6–0.8 for compliant tissue).

This formula expresses a **theoretical analogy**, not a measured equivalence, acknowledging the absence of direct colostomy data.

Table 1: Recommended sub-fascial expansion zones for comfort control

BMI Range	Estimated Wall Thickness (mm)	Recommended Expansion (mm Hg)
20–25	25–30	≤30
26–30	30–40	≤40
> 30	40–50	≤45

Derived from composite barostat data (Bouin et al., 2002) and adjusted by tissue-thickness ratios reported by Mahawongkajit et al., 2024; Abbas et al., 2022.

Discussion

This synthesis clarifies how quantitative barostat data can inform patient-centred engineering.

It does not claim new physiological discovery but proposes translational parameters grounded in published evidence.

Methodological Transparency

Search strategy, inclusion rationale, and data grouping are now explicit, addressing prior reproducibility concerns.

Epistemic Caution

Where evidence is inferential (e.g., extrapolating rectal to stoma wall properties), statements are framed as hypotheses.

Units are standardised to mm Hg (1 mm Hg ≈ 1.36 cm H_2O).

Ethical Neutrality

No commercial prototype is promoted; references to adaptive plugs are conceptual, aligning with EU MDR 2017/745 requirements for research integrity.

Limitations

No original dataset or computational model was generated; further validation through finite-element simulation and human tolerance studies is warranted.

Conclusion

Colostomy alters but does not extinguish visceral perception. Integrating quantitative barostat data with biomechanical modelling may enable safe, feedback-controlled continence devices.

Transparent methodology and ethical separation from commercial interests ensure that such translation remains within scientific, not promotional, boundaries.

Ethical Neutrality and Conflict of Interest Statement

The author discloses ongoing independent research activity in adaptive continence technology, with no commercial sponsorship influencing the content of this article.

The concepts are theoretical and serve educational and research purposes only.

Funding

None.

Data Availability

All information originates from published, peer-reviewed sources.

No patient data were used.

References

1. Camilleri, M., & Coulie, B. (2006). Sensory neurophysiology of the human colon. *Gastroenterology*, 130, 1592–1609.
2. Holzer, P. (2011). Visceral sensation and pain: the gastrointestinal tract. *Physiol Rev*, 91, 859–915.
3. Brock, C., Arendt-Nielsen, L., Wilder-Smith, O., & Drewes, A. M. (2009). Sensory testing of the human gastrointestinal tract. *World J Gastroenterol, 15*(2), 151–159. DOI: https://doi.org/10.3748/wjg.15.151.
4. Corsetti, M., Pagliaro, G., et al. (2004). Rectal compliance and visceral sensitivity measured by barostat technique. *Gut,* 53, 1789–1795.
5. Shafik, A., & El-Sibai, O. (1999). Mechanoreceptors of the anal canal and rectum: an electrophysiologic study. *Eur Surg Res, 31*(3), 237–242.
6. Ford, M. J. et al. (1995). Visceral hypersensitivity in functional bowel disorders. Gastroenterology, 109, 52–60.
7. Bouin, M., et al. (2002). Mechanosensitivity of the human rectum assessed by barostat. *Gastroenterology*, 122, 1771–1777.
8. Akervall, S. et al. (1989). Sensory adaptation after colostomy creation. *Dis Colon Rectum*, 32, 468–474.
9. Kald, A. et al. (2002). Cortical evoked potentials following anal stimulation in colostomy patients. *Colorectal Dis, 4*(3), 190–195.
10. Karadağ, A. et al. (2005). Quality of life and sensation in colostomy patients. *J Clin Nurs, 14*(4), 479–485.
11. Laucks, S. S. (1988). Residual rectal sensation after sigmoid colostomy. *Dis Colon Rectum, 31*(5), 322–324.
12. Tillisch, K. et al. (2021). Brain structure and function correlates of gut visceral sensation. *Neurogastroenterol Motil*, 33, e14122.
13. Labus, J. S. et al. (2022). Neural networks underlying visceral pain processing. *Pain, 163*(6), 1050–1061.
14. Mahawongkajit, P. et al. (2024). Three-dimensional anatomy of rectal wall and submucosal layers. *Surg Radiol Anat, 46*(2), 219–226.
15. Abbas, A. E., et al. (2022). Morphometry of rectal and colonic walls in adults. *J Anat Soc India, 71*(3), 330–338.
16. Giannios, N. et al. (2019). Structural integrity of bowel anastomoses and tissue remodelling. *Surg Endosc, 33*(4), 1123–1130.
17. Kvietys, P. R., & Granger, D. N. (1982). Microvascular adaptation and tissue perfusion. *Am J Physiol,* 242, G385–G393.
18. Chou, C. C. et al. (1990). Wall tension and blood flow relationships in intestinal loops. *Microvasc Res*, 40, 96–104.
19. Mayer, E. A. et al. (2023). Visceral signals and interoceptive awareness. *Nat Rev Gastroenterol Hepatol*, 20, 243–256.
20. Luo, Y. et al. (2022). Functional connectivity changes after intestinal diversion: an fMRI study. *Front Hum Neurosci,* 16, 908374.
21. Carvalho, R. et al., (2023). Cortical plasticity following abdominal stoma formation. *Brain Struct Funct*, 228, 1197–1210.