Neurospine 2024;21(3):753-755.
https://doi.org/10.14245/ns.2448894.447

Neurospine
pISSN 2586-6583 eISSN 2586-6591

Commentary

Pioneering Promotion in Endoscopic Spine Surgery: Innovation of Fluid Dynamics and Pressure Measurement Models: Commentary on "An Experimental Model for Fluid Dynamics and Pressures During Endoscopic Lumbar Discectomy"

Corresponding Author
Facundo Van Isseldyk
https://orcid.org/0000-0003-2236-1037

Hospital Privado de Rosario, Roca 2440, Rosario 2000, Argentina
Email: facundovan@gmail.com

See the article "An Experimental Model for Fluid Dynamics and Pressures During Endoscopic Lumbar Discectomy" via https://doi.org/10.14245/ns.2448350.175.

Yi-Hao Liang[1], Facundo Van Isseldyk[2]

[1]Orthopedic Hospital of Guangdong Provincial Hospital of Chinese Medicine, Guangzhou University of Chinese Medicine, Guangzhou, China
[2]Hospital Privado de Rosario, Rosario, Argentina

The article represents a significant advancement in the field of minimally invasive spine surgery, particularly concerning the understanding of fluid dynamics and pressure changes during full-endoscopic lumbar discectomy (FELD).[1] The study's contributions are noteworthy, as it addresses the critical need for a validated experimental model to study the pressures exerted during endoscopic procedures and their potential clinical implications.

One of the standout features of this study is the development of a novel experimental setup using human cadavers to simulate real-life conditions during endoscopic lumbar discectomy. The meticulous approach to measuring intracranial, intra-, and epidural pressures at different spinal levels is a pioneering effort in this domain.[2] The use of cadaveric models allows for a highly controlled environment where variables can be meticulously managed, ensuring the reproducibility of results. This experimental model is particularly innovative as it captures the dynamic nature of pressure changes during the procedure, providing a comprehensive understanding that static models or *in vivo* studies on live subjects cannot offer.[3] The authors' methodical approach in placing catheters through a sacral approach to monitor pressure changes at lumbar, thoracic, and cervical levels, as well as within the cranial cavity, is commendable. This setup enabled the precise measurement of pressure differentials across various compartments of the spinal axis, a critical factor in understanding the potential complications associated with endoscopic spinal surgeries.[4]

We can see profound implications for the clinical practice of endoscopic lumbar discectomy. By establishing that pressure increases can be sensitively detected with this experimental setup, the study provides a framework for understanding the risks associated with fluid irrigation during endoscopic procedures.[5] The observation that backflow occlusion can elevate pressures within the spinal and cranial compartments highlights a potential mechanism for irrigation-related complications, such as headache, seizure, and autonomic dysreflexia, which are sometimes observed postoperatively in patients undergoing FELD.[6] Interestingly, these complications have always been attributed to interlaminar approaches. One of the many contributions of this study has been to highlight the possibility that, during a transforaminal approach with dural rupture, intracranial and intradural pressure can also increase. Therefore, in the event of a dural rupture, precautions to prevent this should be applied regardless of the approach used. These findings lay the groundwork for future studies to define safe pump pressures, ultimately improving patient safety and surgical outcomes.[7]

Regarding the recent advancements in minimally invasive spine surgery, the use of endoscopic techniques has become increasingly prevalent due to their benefits in reducing tissue damage, shortening recovery times, and improving overall patient outcomes.[8] However, as the study rightly points out, these benefits can be offset by the complications associated with improper management of irrigation pressures during surgery. This experimental model provides a critical tool for further exploration of these complications. It aligns with ongoing research aimed at enhancing the safety and efficacy of minimally invasive procedures by offering a validated method to simulate and measure the impact of different surgical techniques and equipment settings on patient outcomes.[9] For instance, the relationship between irrigation pressure and cerebrospinal fluid dynamics during spinal surgery has been a topic of interest in several recent studies, which have called for more detailed investigations into how these factors influence neurological outcomes.[10] The experimental model developed in this study has vast potential for future research. One of the most exciting prospects is its application in testing different surgical instruments and techniques to determine their effects on intradural, epidural, and intracranial pressures. This could lead to the optimization of surgical protocols and the design of new instruments that minimize the risk of adverse pressure-related events.[11]

Looking into the future, this study opens the door for comparative research involving other minimally invasive techniques, such as microdiscectomy and percutaneous procedures. By comparing the pressure profiles generated by different methods, researchers can better understand the trade-offs associated with each technique and develop strategies to mitigate risks while maximizing the benefits of minimally invasive surgery.[2] The findings of the study also have implications beyond the field of spinal surgery. The methodology could be adapted for use in other types of endoscopic procedures where irrigation pressures are a concern, such as arthroscopic surgeries or endoscopic thoracic surgeries.[3] This cross-disciplinary potential further underscores the importance of the authors' work in advancing the broader field of minimally invasive surgery. While the study is groundbreaking in many respects, there are areas where further research and refinement could enhance the findings. For example, the authors note that the experimental setup, while highly controlled, may not fully replicate the physiological conditions of a living patient.[4] The absence of active blood flow, tissue perfusion, and the dynamic nature of living tissues could influence the generalizability of the findings to clinical practice. Future studies that incorporate these factors, perhaps through the use of animal models or advanced computational simulations, could provide additional insights into how these pressures manifest in a living system.[5] However, the reliance on cadaveric models, while necessary for the initial phase of research, limits the ability to observe long-term effects and the body's compensatory mechanisms in response to pressure changes.[6] Longitudinal studies in live subjects, possibly using advanced imaging techniques to monitor real-time changes during and after the procedure, could complement the findings of this study and provide a more comprehensive understanding of the risks and benefits associated with different irrigation pressures.[7]

In conclusion, the innovative experimental model developed by the authors offers a robust framework for understanding the complex dynamics of pressure changes during endoscopic procedures and sets the stage for future research aimed at improving safety and surgical outcomes.[8] As the field continues to evolve, the insights gained from this study will undoubtedly shape best practices and guiding the development of new surgical technologies.[9] The study not only addresses a critical gap in the current literature but also provides a valuable tool for ongoing research and clinical innovation in spine surgery.[10]

• **Conflict of Interest:** The authors have nothing to disclose.

REFERENCES

1. Farshad M, Stauffer A, Zipser CM, et al. An experimental model for fluid dynamics and pressures during endoscopic lumbar discectomy. Neurospine 2024;21:745-52.
2. Vargas RAA, Hagel V, Xifeng Z, et al. Durotomy- and irrigation-related serious adverse events during spinal endoscopy: illustrative case series and international surgeon survey. Int J Spine Surg 2023;17:387-98.
3. Lewandrowski KU, Hellinger S, De Carvalho PST, et al. Dural tears during lumbar spinal endoscopy: surgeon skill, train-

 https://doi.org/10.14245/ns.2448894.447

ing, incidence, risk factors, and management. Int J Spine Surg 2021;15:280-94.
4. Frazier CH. Operation for the radical cure of trigeminal neuralgia: analysis of five hundred cases. Ann Surg 1928;88:534-47.
5. Mortazavi MM, Adeeb N, Griessenauer CJ, et al. The ventricular system of the brain: a comprehensive review of its history, anatomy, histology, embryology, and surgical considerations. Childs Nerv Syst 2014;30:19-35.
6. Kheram N, Boraschi A, Pfender N, et al. Queckenstedt's test repurposed for the quantitative assessment of the cerebrospinal fluid pulsatility curve. Acta Neurochir (Wien) 2023;165:1533-43.
7. Zipser CM, Spirig JM, Aguirre J, et al. Safety and feasibility of lumbar cerebrospinal fluid pressure and intraspinal pressure studies in cervical stenosis: a case series. Acta Neurochir Suppl 2021;131:367-72.
8. Kheram N, Boraschi A, Pfender N, et al. Cerebrospinal fluid pressure dynamics as a bedside test in traumatic spinal cord injury to assess surgical spinal cord decompression: safety, feasibility, and proof-of-concept. Neurorehabil Neural Repair 2023;37:171-82.
9. Zipser CM, Pfender N, Kheram N, et al. Intraoperative monitoring of CSF pressure in patients with degenerative cervical myelopathy (COMP-CORD Study): a prospective cohort study. J Neurotrauma 2022;39:300-10.
10. Smielewski P, Lavinio A, Timofeev I, et al. ICM+, a flexible platform for investigations of cerebrospinal dynamics in clinical practice. Acta Neurochir Suppl 2008;102:145-51.
11. Amato MCM, Carneiro VM, Fernandes DS, et al. Intracranial pressure evaluation in swine during full-endoscopic lumbar spine surgery. World Neurosurg 2023;179:e557-67.