TECHNICAL NOTE
MINIMALLY INVASIVE SURGERY
http://dx.doi.org/10.1590/S1808-185120222102260083

ENDOSCOPIC INTERLAMINAR SPINE SURGERY GUIDED BY PORTABLE ULTRASOUND: A NEW TECHNIQUE

CIRURGIA ENDOSCÓPICA INTERLAMINAR DA COLUNA VERTEBRAL GUIADA POR ULTRASSOM PORTÁTIL: UMA NOVA TÉCNICA

CIRUGÍA ENDOSCÓPICA INTERLAMINAR DE LA COLUMNA VERTEBRAL GUIADA POR ULTRASONOGRAFÍA PORTÁTIL: UNA NUEVA TÉCNICA

DANTE BERNARDES GIUBILEI[1], DEIVID RAMOS DOS SANTOS[2], MONRES JOSE GOMES[3], MARCIO OLIVEIRA PENNA DE CARVALHO[4]

1. Medical Education at the Centro Universitário do Estado do Pará, Belém, PA, Brazil.
2. Universidade do Estado do Pará – CIPE-UEPA, Belém, PA, Brazil.
3. Brazilian Society of Orthopedics and Traumatology [Sociedade Brasileira de Ortopedia e Traumatologia (SBOT)], Brazilian Society of Ultrasound [Sociedade Brasileira de Ultrassonografia (SBUS)], São Paulo, SP, Brazil.
4. Universidade de São Paulo, São Paulo; Brazilian Society of Orthopedics and Traumatology [Sociedade Brasileira de Ortopedia e Traumatologia (SBOT)], São Paulo, SP, Brazil.

ABSTRACT

This paper describes the technique of interlaminar endoscopic surgery guided by a portable ultrasound device. This innovation allows endoscopic surgery to be performed without the use of real-time radiography, which is associated with a higher risk of radiation damage. The portable wireless ultrasound device used for this technique, which has not been yet described in the world literature for minimally invasive surgeries, can be used as an imaging tool to delimit the interlaminar space in minimally invasive surgeries via both transverse and sagittal views. ***Level of evidence I; Quality of evidence A***.

Keywords: Minimally Invasive Surgery; Spine; Ultrasonography.

RESUMO

Este trabalho descreve a técnica da cirurgia endoscópica interlaminar guiada por dispositivo de ultrassonografia portátil. Essa inovação permite que a cirurgia endoscópica seja realizada sem o uso de radiografias em tempo real que estão associadas ao maior risco de dano decorrentes de radiação. O dispositivo de ultrassom portátil e sem fio usado nessa técnica, que ainda não foi descrito na literatura mundial para cirurgias minimamente invasivas, pode ser usado como ferramenta de imagem para delimitar o espaço interlaminar em cirurgias minimamente invasivas através dos planos transversal e sagital. ***Nível de evidência I; Qualidade da evidência A.***

Descritores: *Procedimento Cirúrgico Minimamente Invasivo; Coluna Vertebral; Ultrassonografia.*

RESUMEN

Este artículo describe la técnica de la cirugía endoscópica interlaminar guiada por un dispositivo de ultrasonografía portátil. Esta innovación permite realizar la cirugía endoscópica sin utilizar radiografías en tiempo real, que se asocian a un mayor riesgo de daños por radiación. El dispositivo de ultrasonido inalámbrico portátil utilizado en esta técnica, aún no descrito en la literatura mundial para cirugías mínimamente invasivas, puede utilizarse como herramienta de imagen para delimitar el espacio interlaminar en cirugías mínimamente invasivas a través de los planos transversal y sagital. ***Nivel de evidencia I; Calidad de la evidencia A.***

Descriptores*: Procedimiento Quirúrgico Mínimamente Invasivo; Columna Vertebral; Ultrasonografía.*

INTRODUCTION

Degenerative disorders of the spine, especially in the lumbar region, are frequent causes of disability worldwide and directly affect the productivity at work and quality of life of individuals affected by this pathology.[1,2]

It is estimated that more than 95% of middle-aged and elderly people suffer or have suffered from spinal disease at some time during their lives,[3] with a trend toward younger people and an increase in degenerative disorders. It is estimated that 10% of cases require invasive interventions when clinical treatment is not successful.[4]

Therefore, spinal diseases are considered a major public health problem and need new surgical intervention methods that provide better functional preservation and postoperative recovery.[4,5] Thus, minimally invasive surgery is the main surgical method for the treatment of spinal diseases[6-8] in various vertebral segments, and for degenerative stenosis, disc herniations, synovial cysts, fractures, and deformities.[5]

In this context, the use of high-definition images becomes fundamental in minimally invasive intraoperative support, with radiography being the most used imaging method. However, due to repeated use and frequent adjustments at the puncture site, there is a risk of radiation damage.[5,6]

Study conducted at the Experimental Spine Surgery and Microsurgery Laboratory, Universidade do Estado do Pará, Belém, PA, Brazil.
Correspondence: Deivid Ramos dos Santos. Travessa Perebebuí, nº 2623, Marco, Belém, Pará, Brasil. CEP: 66087-662. deivid_ramos45@hotmail.com

Received on 02/15/2022 accepted on 03/14/2022
Reviewed by: Dr. Helton Delfino

Recently, ultrasound (US) has been used when real-time imaging is needed in soft tissue surgery.[7] Considering the importance of a complementary imaging method that facilitates the surgical treatment of patients, this paper aims to describe endoscopic interlaminar surgery guided by a portable ultrasound device.

METHODS

In this work, we used a Mobissom MDUO Model M3D-Convex wireless portable ultrasound device at a frequency of 5 Mhz. The patient is placed in a prone position on cushions at the lower abdomen level to flex the lumbar spine and improve the operative field.

A count of the transverse processes is performed by the cross-view method. The transducer is positioned close to the posterosuperior iliac spine, where a sacral view is observed with the medial ridge in the midline. Then, the count is conducted in a cephalic direction while observing the intrathecal space.

By moving the transducer cranially and laterally, the transverse interlaminar view is observed (Figure 1). The probe is rotated to obtain the sagittal view. Then a third count is performed until the desired interlaminar space is reached and a Kelly forceps is placed just below the probe as skin marking.

By keeping the transducer at the same level and inclining it medially, the paramedian sagittal oblique view is achieved through the interlaminar window, making it possible to observe the intrathecal space between the laminae (Figure 2). Deep within this space a dense hyperechoic acoustic shadow called the anterior complex, formed by the posterior cortex of the medulla, the posterior longitudinal ligament, and the anterior dura mater, is located. Subsequently, a skin incision is made with a cold scalpel and the surgical access route is created with the endoscopic dilator.

DISCUSSION

The technique using portable ultrasound to delineate the access route in endoscopic spine surgery is convenient, radiation-free, and allows the acquisition of images in real time.[7,8] There are studies demonstrating the use of traditional, complex, and rigid ultrasound devices complementary to radiography in guiding posterolateral

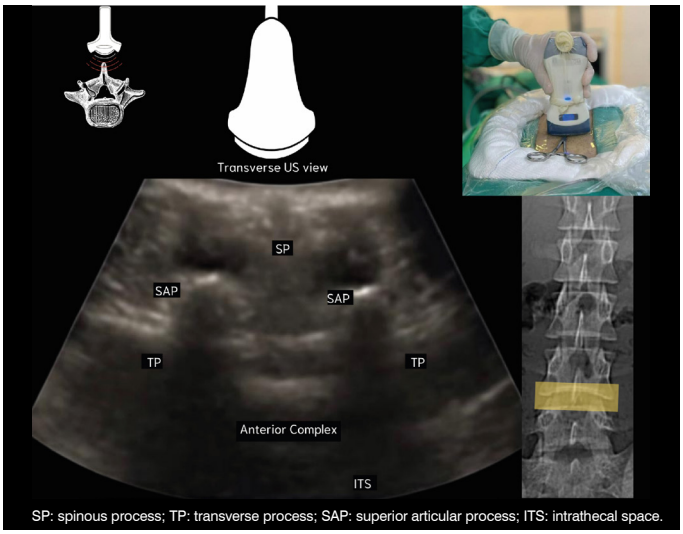

Figure 1. Transverse US view.

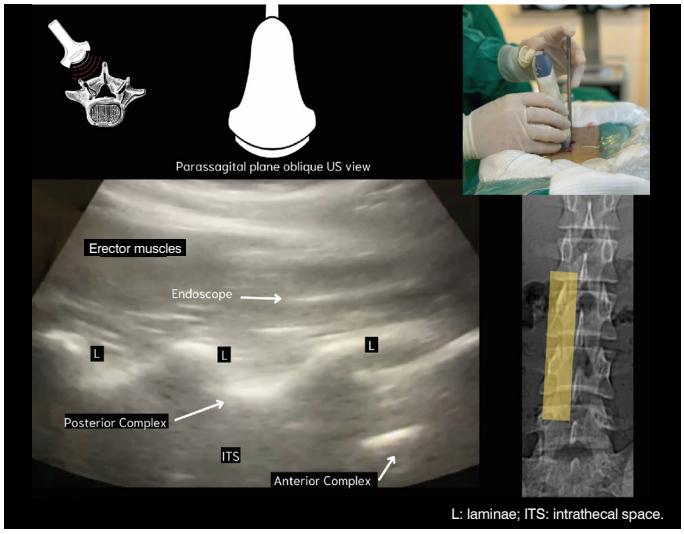

Figure 2. Parasagittal plane oblique US view.

transforaminal puncture and endoscopic lumbar discectomy, with differences of less than 5mm in the puncture site between the methods evaluated.[9,10] This shows that the effectiveness of the US is close to the methods considered the gold standard.

We emphasize that several factors can alter the image acquisition process, such as obesity, muscle atrophy, or calcifications that cause high attenuation and confuse the reference points.[10]

Furthermore, the physician's ability is fundamental, and that is why the US must be performed by a professional experienced in interventional ultrasound focused on the musculoskeletal system in endoscopic spine procedures.[11]

We emphasize that there are significant acoustic losses due to the complete reflection from the cortical bone, making it difficult to observe internal structures of the bone tissue.[9]

The ultrasound manipulation must be gentle but consistent, without deforming the adipose tissue. This technique allows surgeons to observe the distance to the foramen during puncture, providing more precise control near the nerve root.[12,13]

At the beginning stages of the endoscopic interlaminar spine surgery guided by portable ultrasound learning curve, the surgeon may use radiography to verify the accuracy of site delimitation by the new technique. However, as the surgeon´s skill and experience using spinal ultrasound improve, radiography may not be used anymore.

We believe that as technology develops, radiation exposure during surgery will be avoided entirely by using new methods, and in this field, ultrasound has promising results.

CONCLUSION

The new technique using a portable ultrasound device as an imaging tool, not yet described in the literature for minimally invasive surgeries, can be used to delimit the interlaminar space via transverse and sagittal view techniques, reducing the patient's radiation exposure.

All authors declare no potential conflict of interest related to this article.

CONTRIBUTIONS OF THE AUTHORS: Each author made significant individual contributions to this manuscript. DRS and DBG wrote the manuscript and conducted bibliographic research; DBG, MOPC, and MJG performed the surgery, followed up with the patients, and collected clinical data. DRS, DBG, MOPC, and MJG revised the manuscript and contributed to the intellectual concept of the study.

REFERENCES

1. Zhang J, Wang Y, Liu T, Yang K, Jin H. A Flexible Ultrasound Scanning System for Minimally Invasive Spinal Surgery Navigation, IEEE Transactions on Medical Robotics and Bionics. 2021;3(2):426-35. doi: 10.1109/TMRB.2021.3075750.
2. Chen KT, Jabri H, Lokanath YK, Song MS, Kim JS. The evolution of interlaminar endoscopic

spine surgery. J Spine Surg. 2020;6(2):502-12. doi: 10.21037/jss.2019.10.06.
3. Moraes AP, Soares JPCF, Vieira RFS, Santos DR, Giubilei DB, Carvalho MOP. Notification of 6442 cases of bone tuberculosis in brazil: epidemiological profile from 2009 to 2018. Coluna/Columna. 2021;20(2):105-8. doi.org/10.1590/S1808-185120212002239569
4. Santos DR, Giubilei DB, Carvalho MOP, Teixeira ES, Gomes RL, Moraes AP. Epidemiology and mortality of thoracolumbosacral spinal arthrodesis in brazil: the last 10 years. Coluna/Coluna. 2020;19(2):120-2. doi.org/10.1590/S1808-185120201902218933
5. Ganau M, Holly LT, Mizuno J, Fehlings MG. Future directions and new technologies for the management of degenerative cervical myelopathy. Neurosurg Clin N Am. 2018;29(1):185–93.
6. Urakov TM. Practical Assessment of Radiation Exposure in Spine Surgery. World Neurosurg. 2018;120:e752-4. doi: 10.1016/j.wneu.2018.08.158
7. Tildsley P, Lim MJ, Sng BL. Ultrasound of the lumbar spine: Applications and advances. Trends Anaesth Crit Care. 2016;7-8:36-40.
8. Liu YB, Wang Y, Chen ZQ, Li J, Chen W, Wang CF, et al. Volume Navigation with Fusion of Real-Time Ultrasound and CT Images to Guide Posterolateral Transforaminal Puncture in Percutaneous Endoscopic Lumbar Discectomy. Pain Physician. 2018;21(3):E265-78.
9. Zettinig O, Frisch B, Virga S, Esposito M, Rienmüller A, Meyer B, et al. 3D ultrasound registration-based visual servoing for neurosurgical navigation. Int J Comput Assist Radiol Surg. 2017;12(9):1607-19. doi: 10.1007/s11548-017-1536-2
10. Zhang HK, Aalamifar F, Boctor EM. In vivo visualization of robotically implemented synthetic tracked aperture ultrasound (STRATUS) imaging system using curvilinear array. Proc. SPIE 9790, Med Imag. 2016;97901X.
11. Zhang M, Yan L, Li S, Li Y, Huang P. Ultrasound-guided transforaminal percutaneous endoscopic lumbar discectomy: a new guidance method that reduces radiation doses. Eur Spine J. 2019;28(11):2543-50. doi: 10.1007/s00586-019-05980-9
12. Wu R, Liao X, Xia H. Radiation Exposure to the Surgeon During Ultrasound-Assisted Transforaminal Percutaneous Endoscopic Lumbar Discectomy: A Prospective Study. World Neurosurg. 2017;101:658-65.e1. doi: 10.1016/j.wneu.2017.03.050
13. Zhao Y, Bo X, Wang C, Hu S, Zhang T, Lin P, et al. Guided Punctures with Ultrasound Volume Navigation in Percutaneous Transforaminal Endoscopic Discectomy: A Technical Note. World Neurosurg. 2018;119:77-84. doi: 10.1016/j.wneu.2018.07.185