Eur Spine J (2015) 24 (Suppl 3):S445–S446
DOI 10.1007/s00586-015-3950-x

OOT MASTER LECTURE

Neural anatomy, neuromonitoring and related complications in extreme lateral interbody fusion: video lecture

Juan S. Uribe[1]

Keywords XLIF · Lateral · Interbody · Neural anatomy · Lumbar plexus · Neuromonitoring

Learning objectives

Learning objectives for this video lecture include providing a high-level understanding of neural anatomy as it relates to the lateral transpsoas approach as well as techniques to identify and avoid neural structures to minimize risk of neural injury.

Introduction

The lateral retroperitoneal transpsoas approach to the lumbar spine requires passage in close proximity to both superficial and deep neural structures [1, 2]. While the majority of nerves that are at risk for injury in the lateral approach are located on and within psoas major (e.g., femoral and genitofemoral nerves), the subcostal, lateral femoral cutaneous, ilioinguinal, and iliohypogastric nerves are all located outside of the psoas muscle and may be encountered prior to passage through the psoas muscle (superficial nerves). Given the less-invasive nature of the approach adjacent to these structures, a clear understanding of the relevant anatomy with respect to neural architecture, followed by close adherence to intraoperative neuromonitoring and surgical technique may reduce the risk of neurologic injury.

Methods

Literature review and author's opinion.

Results

Most relevant to the lateral approach are the nerves of the lumbar region, with particularly emphasis on the lumbar plexus, which typically originates from spinal levels T12 through L4. The superficial nerves pass at the lower thoracic and upper lumbar levels to innervate the muscles of the abdominal wall. As such, they are at risk of injury during the initial exposure (90° off-midline), especially if electrocautery is used. If electrocautery is to be utilized, bipolar cautery only should be used to avoid thermal injuries. Also, blunt dissection through the abdominal wall muscles will help to avoid sharp dissection of these structures and their resultant effects of abdominal wall paresis [3].

Watch Master Lecture online

Electronic supplementary material The online version of this article (doi:10.1007/s00586-015-3950-x) contains supplementary material, which is available to authorized users.

✉ Juan S. Uribe
juribe@health.usf.edu

[1] University of South Florida Department of Neurosurgery, 2 Tampa General Circle, 7th Floor, Tampa, FL, USA

Most relevant to transpsoas passage are the deep structures of the lumbar plexus. From the upper lumbar to the lower lumbar spine, contributions to the lumbar plexus originate at each spinal level and combine as they pass inferiorly and more anteriorly over the lateral disc space, increasing in mass and profile. While the plexus at the upper lumbar levels covers little of the lateral disc space, at lower lumbar levels the plexus is positioned more anteriorly over the lateral disc space, potentially obstructing a lateral approach. As such, the risk of injury to the plexus increases at lower lumbar levels, particularly at L4–5. Illustrating this, if the lateral aspect of the lumbar disc spaces are divided into quadrants numbered I to IV from anterior to posterior [4], the lumbar plexus is located in zone IV (most posterior) in the upper lumbar levels with the genitofemoral nerve typically located in zone I or II, depending on the level. By targeting approximately zone III for the lateral approach at levels L1–L4, one will typically be anterior to the lumbar plexus and posterior to the genitofemoral nerve. As the lumbar plexus migrates further anterior at L4–5, the approach corridor similarly migrates more anterior to between zones II and III [2]. Other studies quantifying the specific percentage of the lateral disc space covered by the lumbar plexus have found that, on average, the lumbar plexus covers 26–28 % of the posterior aspect of the lateral disc space at L4–5 [5, 6]. While this is consistent with the analysis using quadrants, it suggests that in the majority of cases at L4–5, zone III can still be targeted for approach.

While there is an anatomic justification for the lateral approach to the lumbar spine, variability in the position and size of neural structures requires the use of advanced neuromonitoring integrated into approach and procedural instrumentation to gain real-time information on the location of neural structures. This includes the use of surgeon-directed electromyography (EMG) that can stimulate in directional orientations and provide discrete-threshold responses (NVM5®, NuVasive Inc., San Diego, CA, USA) [7]. This allows for the mapping of neural structures by providing information on the relative distance of nerves to instrumentation (discrete-threshold responses) in specific orientations (directionality). Following placement of the table-mounted retractor, retraction is performed in the anterior direction in order to limit compressing the lumbar plexus within the substance of the psoas muscle and/or against the transverse process, as could occur with posterior retraction. In addition, an efficient discectomy and intervertebral cage placement decreases risk of injury to the plexus through limited amount and duration of retraction.

Conclusions

In summary, avoidance of neurologic complications requires (1) a clear understanding of the regional anatomy, (2) proper patient positioning in the lateral decubitus position, (3) muscle fiber splitting, rather than electrocautery of the abdominal wall, (4) gentle dissection through the retroperitoneal space, (5) directional and discrete-threshold response electrophysiologic monitoring throughout dilation, (6) retraction of tissue in the anterior direction, and (7) meticulous and timely endplate preparation.

Conflict of interest Author is paid as a consultant of NuVasive.

References

1. Dakwar E, Vale FL, Uribe JS (2011) Trajectory of the main sensory and motor branches of the lumbar plexus outside the psoas muscle related to the lateral retroperitoneal transpsoas approach. J Neurosurg Spine 14:290–295
2. Uribe JS, Arredondo N, Dakwar E, Vale FL (2010) Defining the safe working zones using the minimally invasive lateral retroperitoneal transpsoas approach: an anatomical study. J Neurosurg Spine 13:260–266
3. Dakwar E, Le TV, Baaj AA, Le AX, Smith WD, Akbarnia BA, Uribe JS (2011) Abdominal wall paresis as a complication of minimally invasive lateral transpsoas interbody fusion. Neurosurg Focus 31(4):E18
4. Moro T, Kikuchi S-I, Konno S-I et al (2003) An anatomic study of the lumbar plexus with respect to retroperitoneal endoscopic surgery. Spine 28(5):423–428
5. Park DK, Lee MJ, Lin EL, Singh K, An HS, Phillips FM (2010) The relationship of intrapsoas nerves during a transpsoas approach to the lumbar spine anatomic study. J Spinal Disord Tech 23:223–228
6. Regev GJ, Chen L, Dhawan M, Lee YP, Garfin SR, Kim CW (2009) Morphometric analysis of the ventral nerve roots and retroperitoneal vessels with respect to the minimally invasive lateral approach in normal and deformed spines. Spine 34(12):1330–1335
7. Tohmeh AG, Rodgers WB, Peterson MD (2011) Dynamically evoked, discrete-threshold electromyography in the extreme lateral interbody fusion approach. J Neurosurg Spine 14:31–37