ISSN: 0975-3583,0976-2833 VOL14, ISSUE 09, 2023

Original Research Article

NORMATIVE MEASUREMENTS OF DEPTH OF THE POSTERIOR EPIDURAL SPACE AT THE LUMBAR REGION IN ADULT KASHMIRI POPULATION USING MAGNETIC RESONANCE IMAGING – A CROSS-SECTIONAL OBSERVATIONAL STUDY.

S M MUHALLIL[1], SHAMIMA BANOO[2], NASEER AHMAD KHAN[3], JAVED AHMAD KHAN[4], GHULAM MOHAMMAD BHAT[5].

[1]Postgraduate Scholar, Postgraduate Department of Anatomy GMC Srinagar

[2]Assistant Professor, Postgraduate Department of Anatomy GMC Srinagar

[3]Associate Professor, Postgraduate Department of Radio-diagnosis and Imaging GMC Srinagar

[4]*Associate Professor, Postgraduate Department of Anatomy GMC Srinagar

[5]Professor and Head, Postgraduate Department of Anatomy GMC Srinagar

*Corresponding Author: - S M Muhallil

Postgraduate Department of Anatomy GMC Srinagar,

+91-9018833355, drsmmuhallil9@gmail.com

ABSTRACT

Introduction: - The space located between the dura mater and the vertebral canal is known as epidural space. It extends from the foramen magnum to the coccyx. This space is used in Epidural anaesthesia, which combined with general anaesthesia, has become a standard treatment for pain management in major abdominal and thoracic surgery. Also, many physicians use this space for injecting medications such as Epidural space steroid injection which is one of the most commonly used interventions in managing radicular pain caused by nerve irritation. Moreover, for the safe and successful performance of a lumbar puncture and spinal surgery, a good knowledge of the anatomy of epidural space is essential.

Aim of the study: - To provide accurate data on the depth of the posterior epidural space at the lumbar region in a segmental manner in a normal adult Kashmiri population.

Material and Methods: - It is a Hospital-based cross-sectional observational study.

The sagittal T1-weighted MRI scans of 135 patients were observed retrospectively in the Department of Radio-diagnosis and Imaging of Government Medical College Srinagar. The depth was measured at three different lumbar interspaces - L_{1-2}, L_{2-3}, and L_{3-4} using the institutional Osirx MD tool.

Statistical Analysis: - Data were analysed using Statistical Package for Social Science (SPSS) version 25.0 using independent t-test and ANOVA

Results: - Out of 135 patients 45 (33.3%) were male and 90 (66.7%) were females. The mean age of the patients included in the study was 40 years. The mean depth at L_{1-2} in males was

4.63±0.46mm; in females, it was 4.44±0.04 mm with p-value = 0.017. The mean depth at L_{2-3} in males was 4.60±0.49; in females, it was 4.58±0.43mm with p-value = 0.781. The mean depth at L_{3-4} in males was 4.66±0.46; in females, it was 4.61±0.46mm with p-value = 0.544.

Conclusion: - MRI scans reveal the anatomy of epidural space very clearly, and this study provides accurate data on the depth of the posterior epidural space at the lumbar region in the adult Kashmiri population. The data obtained will help in increasing the chances of successful blockage and reducing complications associated with unnecessary Dural punctures. It will also help in choosing the length of the spinal needles used for anaesthesia.

Keywords: - Epidural space, depth, lumbar region, magnetic resonance imaging, measurements, complications.

INTRODUCTION: -

The space located between the dura mater and the vertebral canal is known as epidural space. It extends from the foramen magnum to the coccyx. It was first described by Corning JL in 1901[1] and the first demonstration of this space was done by Dogliotti in 1933[2].

Anteriorly, this space is bounded by the posterior longitudinal ligament and body of vertebrae, laterally by the pedicles and intervertebral foramina whereas posteriorly by the ligamentum flavum, capsule of facet joints and the laminae. Contents of this space include -

1. Fat - It is distributed along the spinal canal (Reina et al., 2006)[3]. It helps in the pulsatile movements of the dural sac and protects the nerves, thus facilitating its movement during flexion and extension.
2. Lymphatics – they are present around the roots of spinal nerves where they remove foreign bodies.
3. Arteries – these are the branches of iliolumbar arteries and are located laterally in the space. Due to their lateral position, they are not injured when a needle is passed through the epidural space.
4. Loose areolar connective tissue.
5. Roots of spinal nerve – Dorsal and Ventral roots.
6. Vertebral venous plexus – It consists of internal and external vertebral venous plexus. The internal vertebral venous plexus lies in the epidural space (Domisse, 1975[4]; Parkin and Harrison, 1985[5]; Brockstein et al., 1994[6]) and consists of four longitudinal vessels which further divide into two anterior vessels and two posterior vessels. The veins of the internal and external vertebral venous plexus along with veins of the vertebral column form Batson's plexus (Domisse, 1975).

These contents of epidural space are present circumferentially in a series of discontinuous compartments separated by zones where the dura mater contacts the wall of the vertebral canal (Hogan, 1998)[7].

The epidural space is classified into cervical, thoracic, lumbar and sacral epidural spaces. At the cervical region, epidural space extends from the foramen magnum to the 7th cervical vertebra. At the thoracic region, it extends from the 7th cervical vertebra to the first lumbar vertebra while at

ISSN: 0975-3583,0976-2833 VOL14, ISSUE 09, 2023

the lumbar region, it extends from the first lumbar vertebra to the first sacral vertebra and at the sacral region epidural space extends from the first sacral vertebra to coccyx.

Development of the epidural space starts in the vertebral canal from 6^{th} week. At the end of the 6^{th} week of intrauterine life, a cellular zone appears at the periphery of primary meninx. The primary meninx is located close to the vertebral bodies. A more condensed cellular layer is visible at the extreme periphery of the primary meninx. Towards the end of the 8^{th} week of intrauterine life, a space appears in the cellular layer. As a result , the cellular layer splits into internal and external layers. The internal layer forms the spinal dura mater while the external condensed layer develops into the endosteum of the vertebral bodies and the intervening space forms the spinal epidural space (M Patelska- Banaszewska-20040)[8].

This space is used in epidural anaesthesia, which combined with general anaesthesia, has become a standard treatment for pain management in major abdominal and thoracic surgery (Willschke et al., 2005)[9]. Also, many physicians have used this space for injecting medications (Cassel, 2000)[10] such as Epidural space steroid injection which is one of the most commonly used interventions in managing radicular pain caused by nerve irritation (Mulligan & Rowlingson, 2001)[11]. However, one of the most important problems encountered while administering epidural anaesthesia or medication is failure to identify the epidural space (Lirk et al., 2004)[12] which results in failure or complications of the procedure. Moreover, inadequate knowledge of the depth of the epidural space and inability to identify it can lead to accidental Dural puncture, which can cause intractable headaches due to leakage of cerebrospinal fluid. Thus accurate identification of the depth of the epidural space is important in determining the functionality of epidural analgesia. This study was performed to provide accurate data of the depth of the epidural space at the lumbar region in a segmental manner in the normal adult Kashmiri population.

METHODS: -

Ethics: Government Medical College Srinagar's institutional review board (IRB) approved the study under Ref. No: IRBGMC/ANAT 342. Informed consent was waived by the Institutional Review Board (IRB) on the basis that it was a retrospective study.

Study area: The study was conducted in the Postgraduate Department of Anatomy in collaboration with the Postgraduate Department of Radio-diagnosis of Government Medical College Srinagar. The study was conducted for a period of 4 months (3 months for data collection and 1 month for compilation and report writing)

Depth of the posterior epidural space at the lumbar region was estimated retrospectively from MRI scans of 135 patients ranging in age from 20 - 60 years. Exclusion criteria included MRI scans with any spinal abnormality such as scoliosis, tumours of the spinal cord or vertebral bodies, metastasis etc.

Measuring Imaging Distances: - All images were viewed using the institutional Osirx MD tool with measurements being made within the program. The sagittal T1-weighted imaging of the lumbar spine was used to measure the depth of the epidural space at the L_{1-2}, L_{2-3} and L_{3-4} interspaces. At each level, the distance was measured from dura mater to ligamentum flavum (Figure 1).

ISSN: 0975-3583,0976-2833 VOL14, ISSUE 09, 2023

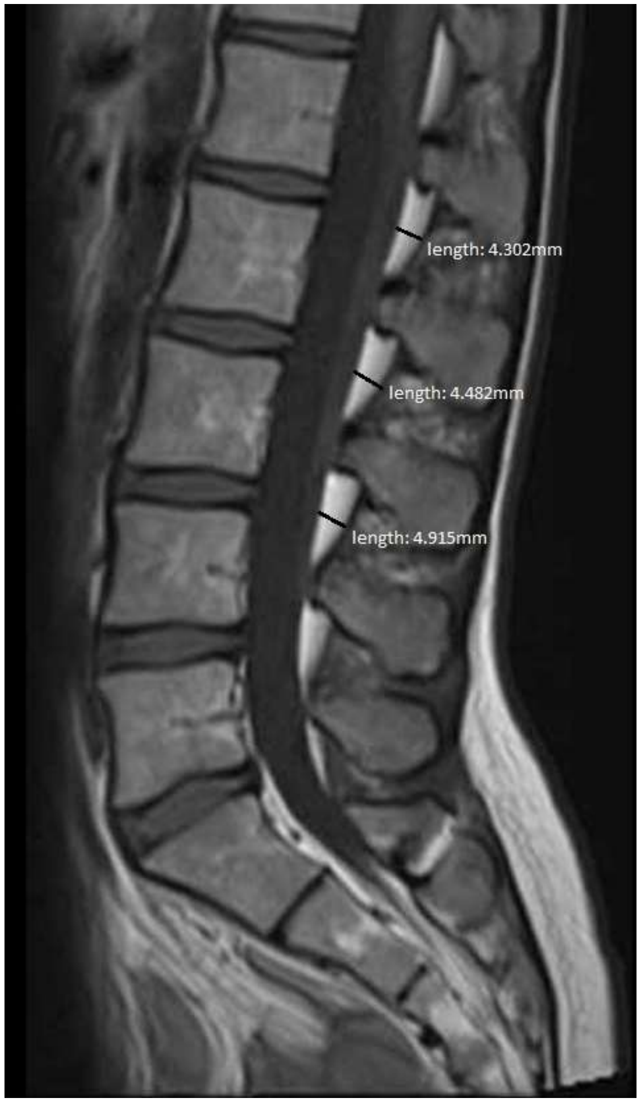

Figure 1 shows measurements of the depth of the posterior epidural space at three different lumbar interspaces – L_{1-2}, L_{2-3}, and L_{3-4}.

L1-2: Interspace between 1st and 2nd lumbar vertebra
L2-3: Interspace between 2nd and 3rd lumbar vertebra
L3-4: Interspace between 3rd and 4th lumbar vertebra

Statistical analysis: - Data were analyzed using Statistical Package for Social Science (SPSS) version 25.0. Independent t-test and ANOVA were used to analyse the data and a p-value ≤ 0.05 was considered statistically significant.

RESULTS

A total of 135 MRI scans of the lumbar region in adults, ranging in age from 20 – 60 years with a mean age of 40 years were Included in the cross-sectional study. Out of 135 patients, 45 (33.3%) were male and 90 (66.7%) were females. The mean values, standard deviation, and confidence interval of the depth of epidural space at three different levels are listed in Table 1. The mean

ISSN: 0975-3583,0976-2833 VOL14, ISSUE 09, 2023

depth of the epidural space in males was observed to be more than in females at L_{1-2}, L_{2-3} and L_{3-4} interspace. The difference between males and females at the L_{1-2} interspace was statistically significant.
Table 1 shows the mean, standard deviation, standard error, and p-value
** denotes statistically significant

DISCUSSION

Measuring the depth of the posterior epidural space of the patient will help in determining the distribution, onset of action and absorption of anaesthetic solutions used in the epidural space, thereby reducing the complication rate of epidural anaesthesia. Variability in the posterior epidural space will also affect the successful application of combined single-dose spinal and catheter epidural anesthesia[13].
Various methods have been used to study the anatomy of the epidural space by researchers. Methods such as epiduroscopy in cadavers and patients, anatomical dissection, Magnetic Resonance Imaging (MRI), Computed Tomography epiduroscopy (Yan et al., 2010)[14], epidural injections of resins and the use of cryo-microtome sectioning in cadavers (Hogan QH,1991)[15] have been used to show the inner layout of the space.

In our study, we have calculated the depth of the posterior epidural space at the lumbar region

Interspace Level	Gender	N	Mean (mm)	Standard Deviation	Standard Error	95% Confidence Interval for Mean		P value
						Lower Bound (mm)	Upper Bound (mm)	
L_{1-2}	Male	45	4.63	0.46	0.07	4.49	4.77	0.017**
	Female	90	4.44	0.39	0.04	4.36	4.53	
L_{2-3}	Male	45	4.60	0.49	0.07	4.45	4.75	0.781
	Female	90	4.58	0.43	0.04	4.49	4.67	
L_{3-4}	Male	45	4.66	0.46	0.06	4.52	4.80	0.544
	Female	90	4.61	0.46	0.04	4.51	4.7	

using magnetic resonance imaging. Knowing the depth will also help in choosing the length of the spinal needles used for anaesthesia.

Bevacqua BK et al[17] used a 17G Tuohy needle to pierce the dura mater after measuring skin epidural distance. They found mean posterior epidural depth was 6.9±4mm, which was found to

ISSN: 0975-3583,0976-2833 VOL14, ISSUE 09, 2023

be somewhat larger and more variable than previously described. The larger value can be attributed to taller or obese patients included in their study.

Hoffmann et al[18] used a Tuohy needle and a locked Whitacre needle to calculate the posterior epidural space depth. They found that the mean posterior epidural depth was 7.1mm through the loss of resistance technique and 4.7mm through the hanging drop technique. The value of the depth obtained through the hanging drop technique was in accordance with our study.

Sang Chul Lee et al[19] calculated the depth of posterior epidural space through the loss of resistance method using a 22G needle and found that the mean depth of posterior epidural space was 6.12±3.49 mm. The measurements of the depth were increased according to the increase of weight and ponderal index.

Akhilesh Gupta et al[20] calculated the depth of posterior epidural space which was in accordance with our study as the mean depth was 4.6mm ±0.14mm.

CONCLUSION

The main advantage of the present study is that the measurements are based on MRI findings, which is accepted as the most accurate imaging technology available. Knowing the expected depth of the posterior epidural space can be of some extra help while performing various procedures, injecting various drugs etc. in the lumbar region. The results of this study are a step in that direction

LIMITATIONS

1. Since the sample size of our study is relatively small, it would not be appropriate to generalize it to the whole population.

2. In this study parameters like BMI, height, and weight have not been taken into consideration

ACKNOWLEDGEMENT

First and foremost, I am extremely grateful to my supervisor, Dr. Shamima Banoo for her invaluable advice, continuous support, and patience during my research. Her immense knowledge and plentiful experience have encouraged me during all the time of my academic research and daily life. I would also like to thank Dr. Manmeet Kour and Dr. Syed Mubashir for their technical support in my study. Finally, I would like to express my gratitude to my parents, and my wife. Without their tremendous understanding and encouragement, it would be impossible for me to complete my research.

REFERENCES

1. Corning, JL. (1885). Spinal anaesthesia and local medication of the cord. N Y Med J, Vol. 42, p. (483).
2. Dogliotti AM. (1933). Research and clinical observations on spinal anaesthesia: with special reference to the peridural technique. Anesthesia & Analgesia, Vol. 12, pp. (59-65).

ISSN: 0975-3583,0976-2833 VOL14, ISSUE 09, 2023

3. Reina MA, Pulido P, Castedo J, Villanueva MC, López A & Sola RG. (2006). Characteristics and distribution of normal human epidural fat. Rev Esp Anestesiol Reanim, Vol. 53, pp. (363-372).
4. Domisse GF. (1975). The arteries and veins of the human spinal cord from birth. Edinburgh: Churchill Livingstone. pp. (81–96).
5. Parkin IG & Harrison GR. (1985). The topographical anatomy of the lumbar epidural space. Journal of Anatomy, Vol. 141, pp. (211-217).
6. Brockstein B, Johns L & Gewertz BL. (1994). Blood supply to the spinal cord: anatomic and physiologic correlations. Ann Vasc Surg, Vol. 8, pp. (394 –399).
7. Hogan QH. (1998). Epidural anatomy: new observations. Can J Anaesth, Vol. 45, pp. (40–48).
8. Magdalena Patelska-Banaszewska, Witold Wozniak, The development of epidural space in human embryos, Folia Morphol (Warsz) 2004;63(3):273-9.
9. Willschke, H., Kapral, S., Bösenberg, A. T., et al. 2005. The impossibility of prediction of the depth of neonatal epidural space-proven with ultrasound. Paediatric Anaesthesia 15(3):799.
10. Cassel, C. K. 2000. Geriatrics for the 3rd millennium. Wiener Klinische Wochenschrift 112:386-393.
11. Mulligan KA & Rowlingson JC. (2001). Epidural steroids. Curr Pain Headache Rep, Vol. 5, pp. (495-502).
12. Lirk, P., Moriggl, B., Colvin, J., et al. 2004. The incidence of lumbar ligamentum flavum midline gaps. Anesthesia and Analgesia 98(4):1178-1180.
13. Ravi KK, Kaul TK, Kathuria S, Gupta S, Khurana S. Distance from Skin to Epidural Space: Correlation with Body Mass Index (BMI). J Anaesthesiol Clin Pharmacol. 2011; 27:39–42.
14. Yan L, Li J, Zhao W, Cui Z, Wang H & Xin L. (2010). The study of epidurography and multispiral CT scanning examinations in the diagnosis of lumbar nerve root canal stenosis. Orthopedics, Vol. 33, pp. (732). doi 10.3928/01477447-20100826-05.
15. Hogan, QH. (1991). Lumbar epidural anatomy: a new look by cryomicrotome section. Anesthesiology, Vol. 75, pp. (767-775).
16. Hamid M, Fallet-Bianco C, Delmas V & Plaisant O. (2002). The human lumbar anterior epidural space: morphological comparison in adult and fetal specimens. *Surg Radiol Anat* Vol. 24, pp. (194-200).
17. Bevacqua BK, Haas T, Brand F. A clinical measure of the posterior epidural space depth. Reg Anesth. 1996; 21:456–60.
18. Hoffmann VL, Vercauteren MP, Vreugde JP, Hans GH, Coppejans HC, Adriaensen HA. Posterior epidural space depth: safety of the loss of resistance and hanging drop techniques. Br J Anaesth. 1999; 83:807–9.
19. Lee SC, Kim SK. The Width of the Epidural Space was Measured during Spinal Anesthesia. Korean J Anestheisol. 1993; 26:520–6.

20. Gupta Akhilesh, Singh Farhat, Mandhyan Rajani, Gupta Anshu. Correlation of skin epidural distance and posterior epidural space depth with age, weight, height, BMI, abdominal girth, and position of the patient: A prospective randomised study. Indian J of Cl. Anaesthesia. 2021;8(3):361–366.
21. Boon, J. M., Abrahams, P. H., Meiring, J. H., and Welch, T. 2004. Lumbar puncture: Anatomical review of a clinical skill. Clinical Anatomy 17(7):544-553
22. Westbrook, J. L., Renowden, S. A., and Carrie, L. E. 1993. Study of the anatomy of the extradural region using magnetic resonance imaging. British Journal of Anaesthesia 71(4):495-498.