The furcal nerve revisited

Nanjundappa S. Harshavardhana,¹ Harshad V. Dabke²
¹Inverclyde Royal Hospital, Greenock; ²Salisbury District Hospital, Wiltshire, United Kingdom

Abstract

Atypical sciatica and discrepancy between clinical presentation and imaging findings is a dilemma for treating surgeon in management of lumbar disc herniation. It also constitutes ground for failed back surgery and potential litigations thereof. Furcal nerve (Furcal = forked) is an independent nerve with its own ventral and dorsal branches (rootlets) and forms a link nerve that connects lumbar and sacral plexus. Its fibers branch out to be part of femoral and obturator nerves in addition to the lumbosacral trunk. It is most commonly found at L4 level and is the most common cause of atypical presentation of radiculopathy/sciatica. Very little is published about the furcal nerve and many are unaware of its existence. This article summarizes all the existing evidence about furcal nerve in English literature in an attempt to create awareness and offer insight about this unique entity to fellow colleagues/professionals involved in spine care.

Introduction

The nerve supply to the lower extremity sclerotomes is by the lumbar and lumbosacral plexus. Compression of nerve roots/rootlets due to lumbar disc herniation may present as sciatica with radicular symptoms.¹ There exists a consistent and predictable correlation between level of compression on MRI or CT myelogram with clinical symptoms and presentation. However atypical presentation and disagreement between imaging studies and clinical symptoms are also not uncommon and constitute a dilemma to a treating surgeon.² Such a scenario may be due to: i) a single lesion (i.e. disc herniation) compressing two nerve roots; ii) congenital anomalies of either nerve or nerve root or rootlets; iii) presence of furcal nerve.³ Very little is written about furcal nerve and this article summarizes all the existing evidence from published articles in English literature. A thorough understanding of anatomical variations and insight into the anomalies of the lumbosacral plexus reduces the incidence of failed back surgery and enhances surgical success. Macnab recommends anomalous nerve roots should be suspected and actively investigated in all failed back surgeries.⁴ It also minimizes risk of potential litigations and its socio-economic burden thereof. Selective nerve root blocks (SNRB) is of both diagnostic and therapeutic utility in functional diagnosis of radicular symptoms.⁵ Dorsal root ganglion (DRG) and spinal nerve is targeted and the epidural sheath is bathed with a local anesthetic. Care is taken to avoid placement of needle tip beyond DRG (i.e. at 6-o’clock in relation to pedicle) which may cause a potential dural puncture.⁶ The DRG is inferior to pedicle in 90% of cases (medial 2%; inferolateral 8%).¹

Anatomy

The lumbar plexus is located within the psoas muscle anterior to the transverse process of lumbar vertebrae.⁵ It is formed by ventral and dorsal rami of L1-L4 nerve roots with contribution from 12th thoracic nerve (i.e. subcostal nerve). A branch from ventral ramus of L4 along with ventral rami of L5 forms the lumbosacral trunk. Sacral plexus is formed by lumbosacral trunk and anterior divisions of 1⁴-⁴ 3⁴ sacral nerves. However variation in the form of both prefix (contribution from L3) and postfix (contribution from L5) sacral plexus is also described.⁶ Figure 1 depicts both lumbar and lumbo-sacral plexus.

Questions

The questions we tried to address are: i) what is furcal nerve?; ii) what is its anatomical course and variations in its anatomy?; iii) what is its applied surgical anatomy and clinical significance in low back surgeries?

Discussion

Furcal nerve (furcal = forked)³ is an independent nerve with its own ventral and dorsal rootlets that most commonly arises at L4 level.³ The second most common site of its location is at L3. It could be called as a link nerve that connects lumbar and sacral plexus and could be found at any level from L1 to S1 levels though there are no reports of its presence at L1 level. Microscopic examination revealed that its dorsal root has a separate DRG and its dimensions are similar to that of its neighboring nerve root.³ Kikuchi et al. described detailed anatomy, course of 85 furcal nerves from 43 cadavers and found 78 (i.e. 93%) were found at L4 level, three at L3 and four at L5 levels.³ Double furcal nerves have an incidence of 0.8% (L3 and L4 more common than L4 and L5). It is most commonly located superior and ventral to L4 nerve root and ran besides it in the intervertebral foramen. It gives branches to: i) femoral nerve, ii) lumbosacral trunk and iii) obturator nerve. The ratio of fibers from furcal nerve to femoral nerve was highest (60%) and least for obturator nerve (10%).³ Furcal nerves could be classified into two sub-types based on their bifurcation in relation to a vertical tangent along the lateral border of pedicle: i) intra-foraminal; ii) extra-foraminal. In an MRI based evaluation of root anomalies involving 376 patients, Hajjiao et al. reported incidence of root anomalies to be 17.3% (65 patients) and 88% of them were due to furcal nerves (i.e. 57/65).⁷ Overall there were 98 furcal nerves in 57 patients of which a majority of them had extra-familial divisions (65/98). Bilateral furcal nerves were seen in 30 and unilateral in 27 patients. 41 of them had furcal nerve at a single level where as 13 patients had them at two levels. The remaining 3 patients had furcal nerve at 3 levels. It is also present in fetuses at as early as 24 weeks of gestation. Vasar et al. undertook a cadaveric study of 10 fetuses with a mean gestational age of 26±1.3 months and found furcal nerve at L4 level in all of them.⁸ Table 1 summarizes the incidence of congenital nerve root anomalies and percentage of furcal nerves observed by independent researchers.³ ⁵ ¹²

Correspondence: Nanjundappa S. Harshavardhana, 2A Albert Road, Gourock PA19 1NH, Scotland, United Kingdom. Tel: +44 7432 254708 - Fax: +44 1475 504434. E-mail: nharshav.outlook.com

Key words: lumbosacral plexus, furcal nerve, radiculopathy, atypical sciatica.

Acknowledgements: the authors would like to thank Dr. Ensor E Transfeldt MD, FACS, attending spinal surgeon. Twin cities spine center, Minneapolis, MN, U.S.A for enlightening us about this entity.

Contributions: the authors contributed equally.

Conflict of interests: the authors declare no potential conflict of interests.

Received for publication: 9 April 2014. Accepted for publication: 9 June 2014.

This work is licensed under a Creative Commons Attribution NonCommercial 3.0 License (CC BY-NC 3.0).
Furcal nerves are the most common cause of atypical presentation of sciatica/radicular symptoms. They may also be part of conjoined nerve roots and combined with intradural anomalies. Despite its high incidence, they haven’t created much interest or attention amongst spinal surgeons. It causes disparity between imaging and clinical presentation characteristics demonstrated by motor weakness and sensory involvement at different levels not explained by normal anatomy/neurology. An awareness of furcal nerve’s existence and insight into potential double root contribution with meticulous evaluation of MRI is important in recognizing these subset of patients.

There were two instances wherein the authors encountered this potential condition while performing a selective nerve root block (SNRB) in awake patients for symptomatic disc herniation which reproduced radicular pain at a different dermatomal distribution (atypical sciatica). Figure 2a-c depicts a L5 SNRB in a 32 year old male who had radiculopathy in both L4 and L5 dermatomes suggestive of a post-fixed furcal contribution (furcal nerve at L5). Figure 2d,e shows AP and lateral fluoroscopy images of a L4 SNRB that reproduced radicular pain at L5 dermatome in a 38 year old female (i.e furcal nerve at L4 – the most common/classical presentation). Transitional features in lumbosacral junction may be present in 6-8% of patients and other spine-segmentation irregularities in up to 20-25% of the population. Transitional features in lumbosacral junction may be present in 6-8% of patients and other spine-segmentation irregularities in up to 20-25% of the population. This may also influence the nerve root projection to a limb and contribute to variable presentation of sciatica. Bartynski et al. performed adjacent double root injections in a series of 132 patients based on pre-op MRI characteristics and 62% (i.e. 82/132) had reproduction of radicular pain.

Conclusions

Furcal nerve is an independent nerve that is present most commonly at L4 level and majority of them bifurcate extra-foraminally. They run parallel to L4 nerve root in intervertebral foramen and are the most common cause of double nerve root contribution in unilateral radiculopathy. Diagnostic SNRB in conjunction with meticulous history and physical examination would guide a surgeon to perform decompression at the correct level to relieve radicular symptoms. Pre-operative evaluation MRI or/and CT myelography for nerve root anomalies is mandatory for all patients undergoing low back surgery to optimize surgical outcomes.
References

1. Cohen MS, Wall EJ, Olmarker K, et al, eds. Anatomy of the spinal nerve roots in the lumbar and lower thoracic spine. In: Rothman-Simeone. The spine. 4th ed. Philadelphia: WB Saunders; 1999.

2. Neidre A, Macnab I. Anomalies of lumbar nerve roots. Review of 16 cases and classification. Spine (Phila Pa 1976) 1983;8:294-9.

3. Kikuchi S, Hasue M, Nishiyama K, et al. Anatomic features of the furcal nerve and its clinical significance. Spine 1986;11:1002-7.

4. Huston CW, Slipman CW. Diagnostic selective nerve root blocks: Indications and usefulness. Phys Med Rehabil Clin N Am 2002;13:545-65.

5. Schulte E, Schumacher U, eds. THIEME Atlas of anatomy: general anatomy and musculoskeletal system. Stuttgart: Thieme; 2006. pp 470-471.

6. Urbanowicz Z. Connections between the lumbar and the sacral plexus in man. Folia Morphol 1981;40:271-9.

7. Spraycar M. Stedman’s medical dictionary. 26th ed. Baltimore: Williams & Wilkins; 1995. p 695.

8. Haijiao W, Koti M, Smith FW, Wardlaw D. Diagnosis of lumbosacral nerve root anomalies by magnetic resonance imaging. J Spinal Disord 2001;14:143-9.

9. Kikuchi S, Hasue M, Nishiyama K, et al. Anatomic and clinical studies of radicular symptoms. Spine (Phila Pa 1976) 1984;9:23-30.

10. Yasar S, Kaya S, Temiz C, et al. Morphological structure and variations of lumbar plexus in human fetuses. Clin Anat 2014;27:383-8.

11. Chotigavanich C, Sawangnatra S. Anomalies of the lumbosacral nerve roots. An anatomic investigation. Clin Orthop Relat Res 1992:46-50.

12. Kadish LJ, Simmons EH. Anomalies of the lumbosacral nerve roots. An anatomical investigation and myelographic study. J Bone Joint Surg Br 1984;66:411-6.

13. Nadich TP, Blaser SI, Delman BN, et al. Congenital anomalies of the spine and spinal cord. In: Atlas SW, ed. Magnetic resonance imaging of the brain and spine. 4th ed. Philadelphia: Lippincott Williams and Wilkins; 2009. pp 1364-1447.

14. Bartynski WS, Kang MD, Rothfus WE. Adjacent double-nerve root contributions in unilateral lumbar radiculopathy. AJNR Am J Neuroradiol 2010;31:327-33.