Ref: Ro Med J. 2022;69(4)
Doi: 10.37897/RMJ.2022.4.1

# The role of spinal ultrasound in the diagnosis of spinal dysraphism – correlation with MRI examination

**Adrian Ioan Toma[1,2], Magdalena Iriciuc[3], Vlad Dima[4], Roxana Elena Bohiltea[4,5], Anca Roxana Bivoleanu[6]**

[1]Neonatology Department, Life Memorial Hospital, Bucharest, Romania
[2]Faculty of Medicine, "Titu Maiorescu" University, Bucharest, Romania
[3]Radiology Department, Medlife Grivita, Bucharest, Romania
[4]Filantropia Clinical Hospital, Bucharest, Romania
[5]"Carol Davila" University of Medicine and Pharmacy, Bucharest, Romania
[6]"Cuza Voda" Clinical Hospital of Obstetrics and Gynecology, Iasi, Romania

## ABSTRACT

The paper presents the clinical, ultrasound and MRI appearances in the case of the closed spinal dysraphisms with a cutaneous/subcutaneous mass: lypomyelomeningocele, posterior meningocele and cervical meningocele. There is mentioned first the classification of these defects, then, for each type, a case example is presented, showing the clinical aspect of the lesion, the ultrasound features and the correlation of ultrasound with MRI images. The examples show a good correlation between ultrasound and MRI, entitling the ultrasound exam to be the first line of exploration in the case of this category of patients.

**Keywords:** MRI, spinal, dysraphism, ultrasound, meningocele

## INTRODUCTION

Spinal dysraphism is represented by an incomplete fusion or absence of fusion of the spinal structures at the midline – neural, mesenchymal or osseous [11]. They appear as a consequence of anomalies of three processes that occur during the embryonic phase of development gastrulation, primary neurulation or secondary neurulation [29]. The spinal dysraphisms could be classified as follows: open spinal dysraphism – a direct contact exists between the neural placode and the external environment (meningocele, myelomeningocele), closed spinal dysraphism with a cutaneous/subcutaneous mass (lypomyelomenigocele, lypomeningocele) and closed spinal dysraphism without a cutaneous mass ( intrathecal lipoma, lipoma of the filum terminale, abnormalities of the notochordal formation or integration(diastematomyelia, neurenteric cysts, split column malformation) [8,11,29,30]. This paper will discuss the presentation (clinical, ultrasound, MRI) of the closed spinal dysraphisms with a cutaneous/subcutaneous mass.

These abnormalities are different depending on their zone of appearance [29]. Thus, in the lumbar area disjunction abnormalities appear, they are characterized by the appearance of lipomatous structures. A defect occurs in the disjunction process (disjunction = separation of the cutaneous ectoderm from the neural ectoderm, with protrusion of mesenchymal between them – the mesenchyma will form the muscles and bones [29]), the mesenchymal tissue enters in the vertebral canal and a lipoma is formed from it [11,29]. There is a communication between the vertebral canal and the subcutaneous space by which the lipoma or placode passes. Depending on the zone where the junction between the placode and the lipoma is situated (placode = zone of embryonal neural tissue, frozen at the stage of neural plate [31]) two types of anomalies are distinguished [29]:

*Corresponding author:*
Adrian Ioan Toma
*E-mail:* adrian_toma@prof.utm.ro

*Article History:*
Received: 5 December 2022
Accepted: 14 December 2022

- Lypomyelomeningocele – the placode comes out from the vertebral canal, being pushed by the subarachnoid space, and thus the placode/lipoma interface is situated outside the spinal canal (Figure 1)
- Lipomyeloschizis (lipomeningocele) – the subcutaneous tumor consists only of a lipoma, that enters the spinal canal and the placode/lipoma interface is situated inside the canal.

Ultrasonographycally, the examination of the dorsal subcutaneous mass identifies only the hyperechoic lipoma, which enters the spinal canal by a defect of the muscular mass and the vertebrae and fuses with the placode in the case of the lipomyelomeningocele [11]. A tethered cord could appear. In the case of the lipomenyngocele, the placode protrudes outside of the canal and fuses with the lipoma there [29]. Sometimes, a structure like a hamartoma could be noticed inside the subcutaneous lipoma [29].

Other types of anomalies found in the lumbar are represented by secondary neurulation defects – posterior or anterior meningocele and terminal myelocystocele [11,29]. In the case of the meningocele, the ultrasound examination finds a transonic subcutaneous collection, without spinal cord tissue – nerves or filum terminal could be encountered

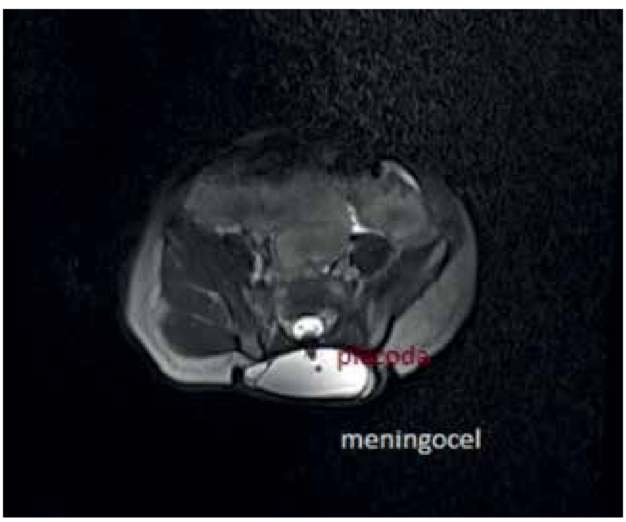

**FIGURE 1.** Lipomyelomeningocele. a) Photograph – subcutaneous mass at the level of the lumbar region; b) Ultrasound exam. A solution of continuity is noted in the posterior wall of the spinal canal and the placode and the placode/lipoma interface are situated outside of the canal; c) MRI examination – the placode is noted as also the placode/lipoma interface; d) ultrasound – axial section

a

b

c


d

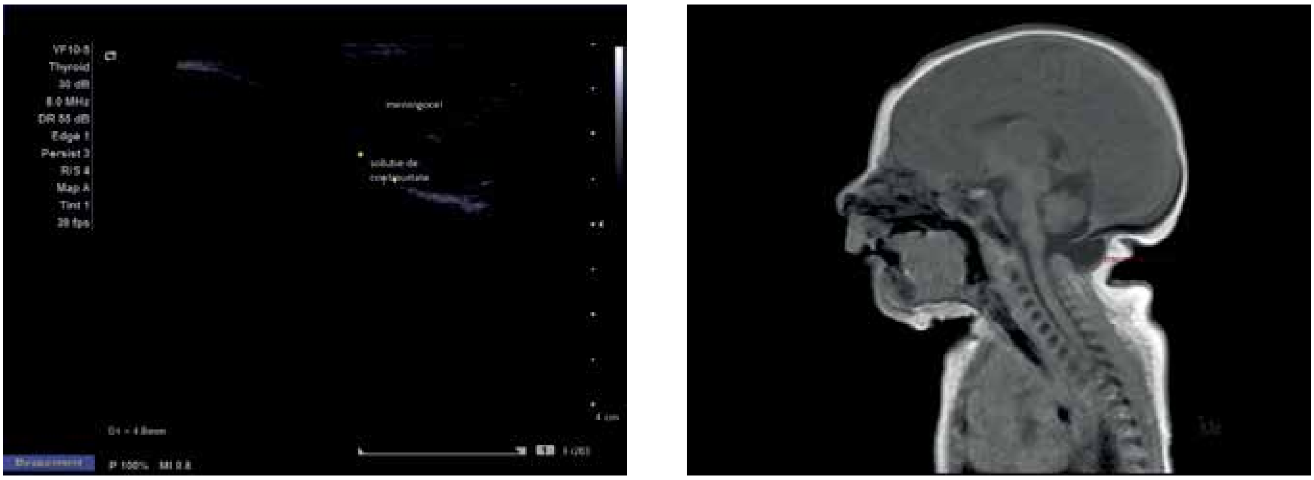



e

**FIGURE 2.** Lombo-sacred myelomeningocele.
a) Photograph – lumbosacral mass covered by abnormal skin in the central area – hemangioma; b) ultrasound exam – sagittal section – the meningocele could be noticed – covered by the skin – the placode is found inside the meningocele with a rudimentary filum terminale that secures the cord inside the meningocele; c) ultrasound – axial section; d) MRI – sagittal section; e) MRI coronal section (both T2 sequences)

there [11]. In the case of myelocystocele, there will be found a dilatation of the central canal due to an obstruction cranial to it [11] – the ultrasound examination finds a transonic structure communicating with the central canal.

In the cervical region, there have been described the myelomeningocele and cervical meningocele [29] (Figure 3). There are extremely rare lesions and the imaging features are similar to the lumbar ones.



a b

**FIGURE 3.** Cervical meningocele. a) Ultrasound – transonic image, without echoes in the interior, that communicates with the spinal canal; b) MRI examination – same appearance.

## CONCLUSION

As previously shown in the case of images of a normal spinal cord, the ultrasound exam could identify correctly the type of malformation in the case of spinal dysraphisms with cutaneous/subcutaneous mass. The ultrasound findings correlated very well with the MRI images. We suggest that the ultrasound examination could be used as a screening tool in case of those masses and the MRI to be performed just in the pre-operatory phase. The ultrasound could not replace MRI but is a useful bedside tool that can be used in order to establish the first diagnosis and to orient future investigations.

*Conflict of interest:* none declared
*Financial support:* none declared

## REFERENCES

1. Deeg KH, Lode HM, Gassner I. Spinal sonography in newborns and infants--Part I: method, normal anatomy and indications. *Ultraschall Med.* 2007 Oct;28(5):507-17.
2. Dick EA, Patel K, Owens CM, De Bruyn R. Spinal ultrasound in infants. *Br J Radiol.* 2002 Apr;75(892):384-92.
3. Gusnard DA, Naidich TP, Yousefzadeh DK, Haughton VM. Ultrasonic anatomy of the normal neonatal and infant spine: correlation with cryomicrotome sections and CT. *Neuroradiology.* 1986;28(5-6):493-511.
4. Dick EA, de Bruyn R. Ultrasound of the spinal cord in children: its role. *Eur Radiol.* 2003 Mar;13(3):552-62.
5. Rossi A, Cama A, Piatelli G, Ravegnani M, Biancheri R, Tortori-Donati P. Spinal dysraphism: MR imaging rationale. *J Neuroradiol.* 2004 Jan;31(1):3-24.
6. Santiago Medina L, al-Orfali M, Zurakowski D, Poussaint TY, DiCanzio J, Barnes PD. Occult lumbosacral dysraphism in children and young adults: diagnostic performance of fast screening and conventional MR imaging. *Radiology.* 1999 Jun;211(3):767-71.
7. The American Institute of Ultrasound in Medicine. Ultrasound Examination of Neonatal and Infant Spine. *AIUM*, 2016.
8. Cramer BC, Jequier S, OGorman AM. Ultrasound of Neonatal Craniocervical Junction. AJNR. 1986;7:449-455
9. Schumacher R, Kroll B, Schwartz M, Emert JA. M Mode Sonography of the Caudal Spinal Cord in Patients with Meningomyelocele. *Radiology*.1992;184:263-265.
10. Deeg KH, Lode HM, Gassner I. Spinal sonography in newborns and infants - part II: spinal dysraphism and tethered cord. *Ultraschall Med.* 2008 Feb;29(1):77-88.
11. Jones BV: Cord Cystic Cavities. Syringomyelia and Prominent Central Canal. *Semin in Ultrasound, CT and MRI*. 2017;38:98-104.
12. Gerscovich EO, Maslen L, Cronan MS et al. Spinal Sonography and Magnetic Resonance Imaging in Patients with Repaired Myelomeningocele: Comparison of Modalitie *J Ultrasound Med* 1999;18:655-64.
13. Kawahara H, Andou Y, Takashima S et al. Normal development of the spinal cord in neonates and infants seen on ultrasonography. *Neuroradiology*. 1997;29:50-52.
14. Nelson, MD, Sedler JA, Gilles FH. Spinal Cord Central Echo Complex. Histoanatomic Correlation. *Radiology.* 1999;170:479-481
15. Rowland Hill CA, Gibson PJ: Ultrasound Determination of the Normal Location of the Conus Medularis in Neonates. *AJNR Am J Neuroradiol.* 1995;16:469-472.
16. Beek EJA, de Vries LS, Gerards LJ, Mali WPTM. Sonographic determination of the position of the conus medularis in premature and term infants. *Neuroradiology*. 1996;38:S174-S177.
17. Zieger M, Dorr U. Pediatric spinal sonography: Part I. Anatomy and examination technique. *Pediatr Radiol*. 1988;18:9-13
18. Korswick HE, Keller MS. Sonography of Occult Dysraphism in Neonates and Infants with MR Imaging Correlation. R*adioGraphics.* 1992;12:298-306.
19. Long FR, Hunter JV et al. Tethered cord and associated vertebral abnormalies in children and infants with imperforate anus: with MR imaging and plain radiography. *Radiology.* 1996;200:377–382
20. Unsinn KM, Galey T, Freund MC, Gassner I. US of the Spinal Cord in Newborns. Spectrum of Normal Findings, Variants, Congenital Anomalies, and Acquired Diseases. *RadioGraphics.* 2000;20:923-938
21. Lowe LH, Johanek A, Moore CW. Sonography of the Neonatal Spine: Part 2, Spinal Disorders. *ARJ*. 2007;88:739-744.

22. Coley BD, Shiels WE II, Hogan MJ. Diagnostic and interventional ultrasonography in neonatal and infant lumbar puncture. *Pediatr Radiol.* 2001;31:399–402.
23. Robinson AJ, Russell S, Rimmer S. The value of ultrasonic examination of the lumbar spine in infants with specific reference to cutaneous markers of occult spinal dysraphism. *Clinical Radiology*. 2005;60:72–77
24. Choi SJ, Yoon HM, Hwang JS et al: Incidence of Occult Spinal Dysraphism Among Infants With Cutaneous Stigmata and Proportion Managed With Neurosurgery A Systematic Review and Meta-analysis. *JAMA Network Open*. 2020;3(7):e207221. doi:10.1001/jamanetworkopen.2020.7221
25. Medina LS, Crone K, Kuntz KM. Newborns With Suspected Occult Spinal Dysraphism: A Cost-Effectiveness Analysis of Diagnostic Strategies *Pediatrics*, 2001, 180, URL: http://www.pediatrics.org/cgi/content/full/108/6/e101;cost-effectiveness analysis, occult spinal dysraphism, newborns, MRI, ultrasound.
26. Rypens E, Avni EF, Matos C, et al. Atypical and equivocal sonographic features of the spinal cord in neonates. *Pediatr Radiol*. 1995; 25:429-432
27. Lowe LH, Johanek A, Moore CW. Sonography of the Neonatal Spine. Part I. Normal Anatomy, Imaging Pitfalls and Variations That May Simulate Disorders. *ARJ*. 2007;88:733-8.
28. Tortori-Donati P, Rossi A, Cama A. Spinal dysraphism: a review of neuroradiological features with embryological correlations and proposal for new classification. *Neuroradiology*. 2000;47:471-91.
29. Volpe JJ Ed Volpe s Neurology of The Newborn, Sixth Edition. Elsevier, 2018
30. Nadich TP, Zimmermannn RA, McLone DG et al. Congenital anomalies of the spine and spinal cord. In: Atlas SW (ed). Magnetic Resonance Imaging of brain and spine. 2nd Ed. Lippincott-Raven. Philadelphia, 1996, p. 1265-1337.