

[Search Results](#)

Journal of Pediatric Orthopaedics B

Issue: Volume 14(3), May 2005, pp 185-188

Copyright: © 2005 Lippincott Williams & Wilkins, Inc.

Publication Type: [SPINE]

ISSN: 1060-152X

Accession: 01202412-200505000-00008

Keywords: sonography, spinal cord, spinal column, newborns, tethered cord

[SPINE] [Previous Article](#) | [Table of Contents](#) | [Next Article](#)

Spinal cord sonography in newborns: anatomy and diseases

Azzoni, Roberto^a; Gerevini, Simonetta^b; Cabitza, Paolo^a

Author Information

^aOrthopaedic Department, Medical School, State University of Milan, Policlinico San Donato

^bNeuroradiology, San Raffaele Institute of Milan, Milan, Italy

Correspondence and requests for reprints to Roberto Azzoni, MD, Clinica Ortopedica dell'Università, Policlinico, Via Morandi 30, 20097 S. Donato milanese, Milan, Italy

Tel/fax: +39 02 52774632; e-mail: roberto.azzoni@unimi.it

[Back to Top](#)

Abstract

Sonography of the spinal cord is a relatively recent acquisition that makes it possible to evaluate the content of the vertebral canal and study its pathologies. The aim of this study was to verify the reliability of ultrasound images by comparing them with magnetic resonance ones in healthy controls as well as in patients referred to us between 1991 and 2004. In this period, we studied 436 newborns: 88 without any suspicion of disease as normal controls, and 348 with suspected congenital diseases or in order to screen the children of diabetic mothers, a group that has shown an increased incidence of dysraphism. After explaining normal sonograms, we describe the pathological pictures observed in the 12 pathological cases in our series: conus hypomobility in five cases; lack of visualization of the conus medullaris in one case; and an enlarged endymal canal in six cases. Four cases presented all three pathological conditions, and seven the association of two pathologies. All of these patients also underwent magnetic resonance imaging (MRI), which confirmed the ultrasound findings in four cases: three cases of enlarged endymal canal and one of tethered cord hypomobility of the roots with an associated lipoma; the MRI findings were normal in the other seven cases. Sonography was highly specific but not very sensitive, because it is partially

Article Tools

 [Article as PDF](#)

 [Complete Full Text](#)

 [Abstract Reveal](#)

 [Print Preview](#)

 [Email Jumpstart](#)

 [Email Article](#)

 [Save Article](#)

 [Add to My Favorites](#)

 [Export All](#)

 [Find Citing](#)

 [Find Similar](#)

[About this Journal](#)

[Request Permissions](#)

Email Jumpstart

Your Jumpstart

<http://ovidsp>

200505000-00008

Please enter t

The email add

Email

Outline

- [Abstract](#)
- [Introduction](#)
- [Methods](#)
- [Results](#)
- [Discussion](#)
- [References](#)
- [IMAGES](#)

conditioned by patient collaboration. Nevertheless, subsequent MRI confirmed 37% of the suspected pathological cases. The ultrasound resolution of both normal and pathological spinal cord structures was particularly clear. The images were similar, easily comparable and often identical to the MRI results, although MRI was certainly more sensitive. The advantages of sonography are its non-invasiveness, low cost, the virtually ubiquitous availability of ultrasound equipment, the simplicity and rapidity of the examination, and its specificity. We believe that the indications for its use are lumbo-sacral skin alterations, neurological disorders caused by congenital malformations, traumas due to childbirth or a lumbar puncture, occult dysraphism, all of the compressive spinal cord neo-formations involving nerves, the dura mater and vertebral bone and joint structures, and the screening of the newborns of diabetic mothers.

[Back to Top](#)

Introduction

Ultrasound diagnosis has long been used in the diagnosis of joints, muscles, tendons and peripheral nervous system diseases. It is also widely used in newborns as a means of studying developmental dysplasia of the hip [1] and less frequent diseases, such as fleeting coxitis [2] and epiphysiolysis of the femoral head.

There are no published ultrasound studies of spinal content in adults because the vertebral bone structures obstruct the passage of ultrasound waves, but sonography of the spine of the fetus has been used for the prenatal diagnosis of vertebral malformations [3].

Ultrasound studies of the spinal cord and cauda equina in neonatal spines are feasible because the waves can pass through the still non-ossified vertebral bone tissue [4]. Furthermore, some authors use ultrasounds to guide lumbar punctures in neonates and infants [5]. One of the first ultrasound studies of neonatal spine was undertaken by Sceibe in 1983 in order to investigate occult dysraphism [6].

The aim of this study was to confirm the validity of sonography in diagnosing neonatal spine pathologies by means of the correct recognition of spinal bone and joint structures and the content of the vertebral canal in our case series; the

pathological cases also underwent nuclear magnetic resonance imaging (MRI).

We studied the spines of 436 newborns: 88 normal spines of neonates who underwent hip sonography for purposes of congenital dysplasia screening, and 348 because of suspected congenital diseases or in order to screen the children of diabetic mothers, who have shown an increased incidence of dysraphism [7,8].

This enabled us to study the normal and pathological aspects of the ultrasound appearance of spine and spinal cord anatomy, and compare it with the results of MRI.

[Back to Top](#)

Methods

Between January 1991 and January 2004, we used sonography to study the spines of 436 newborns aged 1-90 days: 88 underwent sonography for the purpose of developmental dysplasia of the hip screening; 88 because of the sacral presence of faveola, tufts of hair or skin excrescences, and 260 children of diabetic mothers because there is evidence that diabetes may be a cause of dysraphism [7,8].

The examinations were performed at the age of 7-90 days in the normal controls, and during the first 3 days of life in the case of suspected disease.

With the consent of the parents, at the same time as a hip sonography for the normal controls, we also made some longitudinal and transversal ultrasound scans of the dorsal and lumbo-sacral spine [9].

The newborns were positioned in prone decubitus with the spine in flexion. The normal control subjects were examined using an ATL HDI 5000 SonoCT (Advanced Technology Laboratories Ultrasound, Bothell, Washington, USA), and those with suspected diseases were examined using a GE MS Logic 500 (General Electric, Milwaukee, Wisconsin, USA); the images were recorded by means of a Sony Video Graphic Printer UP-895 CE (Sony Corporation, Tokyo, Japan). We used high frequency 7.5 and 10 MHz real-time linear ultrasound probes, without a stand-off pad.

In the case of longitudinal views, the probe must be positioned on the plane of the spinous apophysis in such a way that the ultrasound beam can penetrate between

one vertebra and another, and thus reach the content of the vertebral canal. This can be done because the partial presence of non-ossified bone tissue and the flexed position of the spine allows multiple intervertebral spaces to be visualized using a single scan, thus making it possible to study a relatively broad tract of the spinal cord.

In order to obtain transversal views, the probe must be positioned between one spinous process and another in such a way as to allow the ultrasound beam to penetrate the space between two vertebrae.

All of the images have been standardized to the usual sonographic view, and so it is necessary to imagine the newborn in a prone position. Consequently, the posterior part is always at the top and the anterior part at the bottom, with the caudal and cranial parts respectively on the right and left of the images.

[Back to Top](#)

Results

A longitudinal scan of a normal neonatal spine shows a number of features ([Fig. 1](#)). The bone structures of the spinous apophyses are hyperechoic, and make important reference points for obtaining scans on the median line. The spinous apophyses are the only structures whose cones of acoustic shadow hinder the visualization of the underlying medullary content, but the non-ossification of the posterior arch allows the ultrasound waves to penetrate the overlying structures. The vertebral bodies are clearly visible, and appear as hyperechoic structures underlying the medullary content, interrupted by the cones of shadow of the spinous apophyses, thus making it possible to recognize the site of the scans. Furthermore, the pia mater and dura mater can be seen behind the vertebral bodies as a hyperechoic striation that is clearly distinguishable from the vertebral soma. The medullary content is a hyperechoic structure with horizontal bands of echoes that are also interrupted by the shadow cones of the spinous apophyses. Depending on the level of the scan, it represents the spinal cord or the cauda equina. The central complex can be seen as an echoic striation, over which the pia mater can again be seen as a hyperechoic striation and the posterior subarachnoid space as a hypoechoic band.

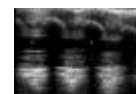


Fig. 1

The transversal ultrasound appearance of a normal spine ([Fig. 2](#)) shows with two lateral hypoechoic areas constituted by the peri-vertebral muscle mass; two oblique, lateral hyperechoic bands due to the cartilage of the vertebral arches;



Fig. 2

echoic medullary content, with roundish areas attributable to the roots, and anterior and posterior hypoechoic areas attributable to the sub-arachnoid space, inside which there is a small, roundish echoic area due to the filum terminale; and two sickle-shaped echoic images ventrally and dorsally to the medullary content, which can be attributed to the pia mater and dura mater.

Ultrasounds can also be used to evaluate the size of the ependymal canal, thus making it possible to identify cases of pathological enlargement ([Fig. 3](#)). If it is not possible to see the medullary cone at the level of vertebrae D12-L1, this is a sign that it is incorrectly positioned more distally, as in the case of tethered cord syndrome ([Fig. 3](#)) [[10](#)].

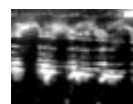


Fig. 3

In addition, sonography allows a dynamic view of the medullary content, and, consequently, the evaluation of the mobility of the roots. Another diagnostic possibility is the recognition of other congenital malformations or neoformations.

Among our 348 suspected cases, sonography revealed 12 pathological cases: five cases of conus hypomobility; one case in which the conus medullaris could not be visualized; and six cases of an enlarged ependymal canal. Four cases presented all three pathological conditions, and seven the association of two pathologies. All of these patients also underwent MRI, which confirmed the ultrasound findings in four cases: three cases of enlarged ependymal canal and one of tethered cord hypomobility of the roots with an associated lipoma ([Figs 4 and 5](#)); the MRI findings were normal in the other seven cases.



Fig. 4



Fig. 5

[Back to Top](#)

Discussion

Sonography was highly specific (98%) but not very sensitive, because it is partially conditioned by patient collaboration. Nevertheless, subsequent MRI confirmed 37% of the suspected pathological cases. The sonographic images of both normal and pathological spinal anatomy was particularly clear, although they must be obtained using adequate ultrasound equipment and appropriate

probes. They are similar to, easily comparable with, and often identical to MRI, although the latter are certainly more sensitive.

We believe that the ultrasound examination of the spine of a newborn may offer a further means of first-line diagnostic imaging for congenital and acquired diseases. Its advantages are its non-invasive nature, low cost, the almost ubiquitous availability of ultrasound equipment, the simplicity and speed of the examination itself, and its specificity. Furthermore, unlike MRI (which may require the use of general anaesthesia in order to ensure immobility), sonography can be performed simply relying on the collaboration of the newborn adequately assisted by his or her parents.

In line with what has been published in the literature, we believe that the indications for the use of sonography are lumbo-sacral skin alterations [11], neurological disorders due to congenital malformations (myelocele, myelomeningocele, diastematomyelia, terminal myelocystocele, lateral meningocele, syringomyelia, hydromyelia, tethered cord syndrome) [3,4,6,10,12,13], traumas caused by childbirth or a lumbar puncture [14], occult dysraphism, all of the compressive spinal cord neo-formations involving nerves, the dura mater and vertebral bone and joint structures [13], and the screening of the newborns of diabetic mothers [7,8].

Sonography can be a valid first-approach instrumental diagnostic method in newborns up to the age of 6 months; if necessary, it can be followed by MRI examinations of pathological cases warranting further diagnostic investigation [15].

Early sonographic studies of the spine of neonates allow a precise evaluation of the spinal canal and its content, thus excluding possibly significant pathological conditions. In patients with normal sonographic results, no further examinations are necessary; in those showing spinal malformations, further instrumental diagnostic investigations should be undertaken before having recourse to surgery. In the case of complex malformations, sonography can also be useful in

evaluating other associated malformations [13].

[Back to Top](#)

References

1. Graf R. New possibilities for the diagnosis of congenital hip joint dislocation by ultrasonography. Arch Orthop Traum Surg 1983; 3:354-359. [\[Context Link\]](#)
2. De Pellegrin M, Fracassetti D, Ciampi P. Coxitis fugax: The role of diagnosis imaging [in German]. Orthopade 1997; 26:858-867. [\[Context Link\]](#)
3. Achiron R, Lipitz S, Grisaru D, Ranan M, Barziv J, Berkenstadt M, Goldman B. Second-trimester ultrasonographic diagnosis of segmental vertebral abnormalities associated with neurological deficit: a possible new variant of occult spinal dysraphism. Prenat Diagn 1996; 16:760-763. [\[Context Link\]](#)
4. Staatz G, Hubner D, Wildberger JE, Gunther RW. The US panorama of the spinal cord with high localisation of the conus medullary in the newborns and breast-fed babies [in German]. Rofo 1999; 170:564-567. [\[Context Link\]](#)
5. Coley BD, Shiels WE, Hogan MJ. Diagnostic and interventional ultrasonography in neonatal and infant lumbar puncture. Pediatr Radiol 2001; 31:399-402. [\[Context Link\]](#)
6. Sceibe W, James HE, Leopold JR, Hilton SW. Occult spinal dysraphism in infants: screening with high-resolution real-time ultrasound. Radiology 1983; 146:743-745. [\[Context Link\]](#)
7. Chang TI, Horal M, Jian SK, Wang F, Patel R, Loeken MR. Oxidant regulation of gene expression and neural tube development: Insights gained from diabetic pregnancy on molecular causes of neural tube defects. Diabetologia 2003;

46:538-545. [\[Context Link\]](#)

8. Myriantopoulos NC, Melnick M. Studies in neural tube defects. I. Epidemiologic and etiologic aspects. Am J Med Genet 1987; 26:783-796. [\[Context Link\]](#)

9. Vocke AK, Ruhmann O, Lazovic D. Standardized sonographic investigation of the lumbar spine [in German]. Klinische Padiatrie 1999; 211:22-26. [\[Context Link\]](#)

10. Sahin F, Selcuki M, Ecin N, Zenchiroglu A, Unlu A, Ylmaz F, et al. Level of conus medullaris in term and preterm neonates. Arch Dis Child Fetal Neonatal Ed 1997; 77:67-69. [\[Context Link\]](#)

11. Hermann TE, Oser RF, Shackelford GD. Intergluteal dorsal dermal sinuses. The role of neonatal spinal sonography. Clin Pediatr 1993; 32:627-628. [\[Context Link\]](#)

12. Konner C, Gassner I, Mayr U, Kreczy A. The diagnosis of diastematomyelia with ultrasounds [in German]. Klein Padiatr 1990; 202:124-128. [\[Context Link\]](#)

13. Unsinn KM, Geley T, Freund MC, Gassner I. US of the spinal cord in newborn: spectrum of normal findings, variants, congenital anomalies, and acquired diseases. Radiographics 2000; 20:923-938. [\[Context Link\]](#)

14. Rudas G, Almassy Z, Varga E, Somogyvary Z, Taylor GA Alterations in spinal fluid drainage in infants with hydrocephalus. Pediatr Radiol 1997; 27:580-582. [\[Context Link\]](#)

15. Rohrschneider WK, Forsting M, Darge K, Troger J. Diagnostic value of spinal US: Comparative study with MR imaging in pediatric patients. Radiology 1996;

Keywords: sonography; spinal cord; spinal column; newborns; tethered cord

IMAGE GALLERY

[Select All](#) [Unselect All](#)

 [Export Selected to PowerPoint](#)

One of more images must be select in order to export to PowerPoint.

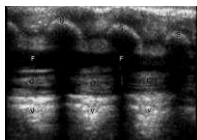


Fig. 1



Fig. 2

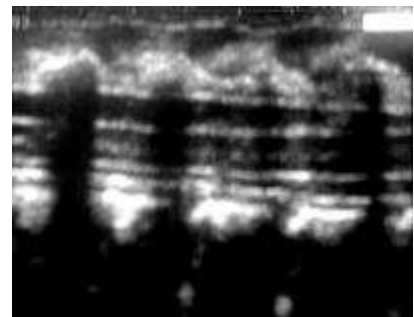


Fig. 3

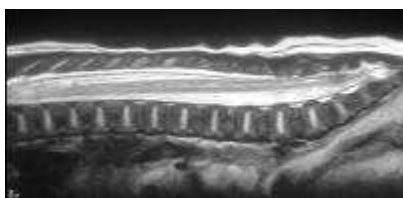


Fig. 4

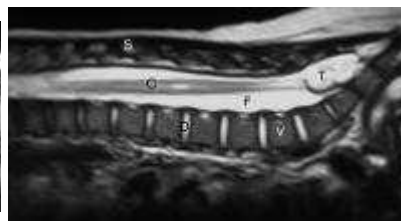


Fig. 5

[Back to Top](#)

[▢ Previous Article](#) | [Table of Contents](#) | [Next Article ▢](#)