3D CONSTRUCTIVE INTERFERENCE IN STEADY STATE (3D-CISS) IMAGING OF THE OPTIC NERVES AND OPTIC CHIASM

Conference Paper · March 2011

DOI: 10.13140/2.1.5085.5365

2 authors:

Arnaud Louvet
Laboratoire de Biorhéologie et d'Ultrasonographie Médicale
18 PUBLICATIONS **401** CITATIONS
SEE PROFILE

Anne-Carole Duconseille
6 PUBLICATIONS **32** CITATIONS
SEE PROFILE

3D CONSTRUCTIVE INTERFERENCE IN STEADY STATE (3D-CISS) IMAGING OF THE OPTIC NERVES AND OPTIC CHIASM

AC. Duconseille, A. Louvet, P. Lazard. CIREN, 80 rue Péreire, 78100 Saint-Germain-en-Laye, France

INTRODUCTION / PURPOSE

In humans, MR is uniquely suited to image the entire course of the optic pathway from the globe to the primary visual cortex in the occipital lobe.

Relatively large lesions involving or compressing optic nerves and chiasm in small animals can be diagnosed with conventional two-dimensional turbo-spin-echo sequences (2D TSE) (1,2); however an examination technique that enables the detection of the normal optic nerves in their course from apparent origin and assumed to be adequate for the diagnosis of even small lesions at the initial stage of the disease has not been currently described in the veterinary literature.

The 3D-CISS sequence is extremely useful for the assessment of the optic nerve, chiasm and optic tracts as it provides an excellent cerebrospinal fluid-nerve contrast, an excellent resolution due to gapless, very thin slices (0.6-0.7 mm reconstructed every 0.3-0.35 mm) and excellent 2D multiplanar curved reconstructions along the optic nerve.

3D-CISS is based on a 3D gradient echo sequence with gradient refocusing in all three directions (true FISP ; fast imaging with free precession). It generates a steady state contribution of the transverse magnetization for tissues with long T2 and is therefore a T2 weighted sequence.

In humans, optic nerves and chiasm detectability with 3D-CISS sequence has been proven superior to conventional 2D TSE (3). The same findings must be anticipated in small animals considering the fact that optic nerves and chiasm are far smaller in dogs than in Humans.

The aim of the study was therefore to evaluate T2* weighted 3D-CISS sequence in the detection of fine anatomy of the optic nerves and optic chiasm in the dog and to show its potential diagnostic applications in selected clinical cases.

METHODS

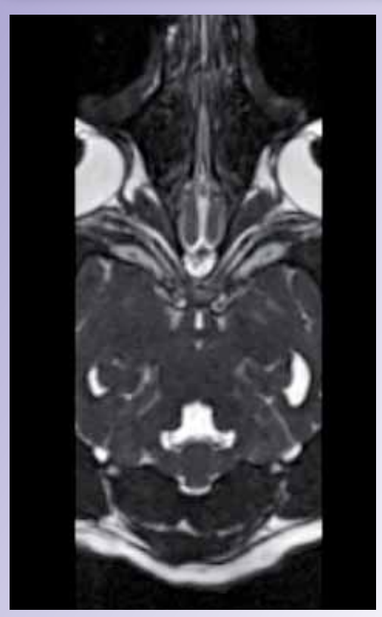
Animals were sedated, orotracheally intubated and maintained under anaesthesia with isoflurane in oxygen. Dogs were placed in dorsal recumbency with the head in a circular polarized emitting-receiving extremity coil. After conventional 2D TSE sequences, the 3D-CISS sequence was prescribed in the axial plane. Dorsal, sagittal or curved MPR reconstructions were examined in the embedded PACS workstation or offline with commercially available software.

The sequences parameters are listed in Table.

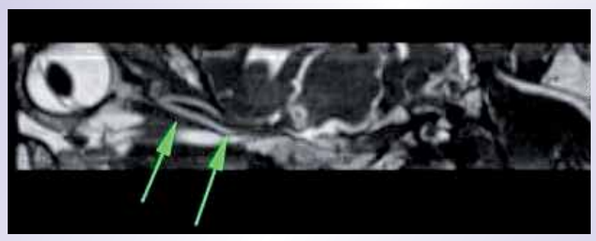
Sequence	3D CISS
Contrast	T2
Bandwidth (Hz/pixel)	130
Repetition Time ms (TR)	11.16
Echo Time ms (TE)	5.58
Flip angle (degrees)	70
Field of view (mm)	180
Matrix	320
Pixel size	0.5
No. of acquisitions	1
No. of partitions	68
Orientation	Transverse
Measurement time	4.39 min
Effective slice thickness (mm)	0.6

RESULTS:

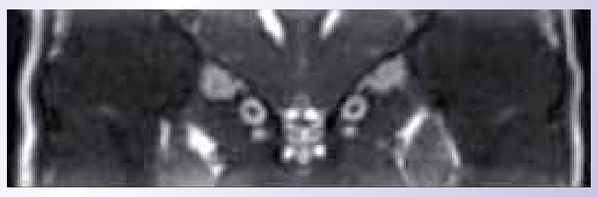
NORMAL FINDINGS



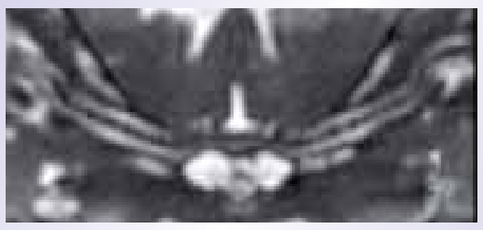
Normal dog – 3D-CISS MPR in dorsal view showing the entire course (intraorbital, intracanalicular and intracranial) of both optic nerves and CSF in the subarachnoid space around the nerves.



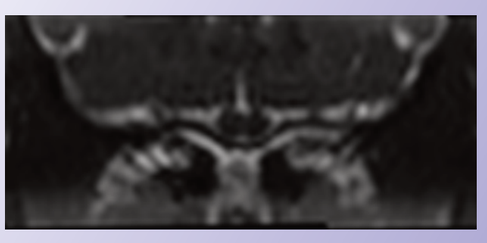
Normal dog – 3D-CISS parasagittal reconstruction showing the entire course of the optic nerve from optic chiasm to papilla.



Normal dog – 3D-CISS axial reconstruction showing transverse images of both optic nerves surrounded by a bright annular signal representing CSF in the subarachnoid space.

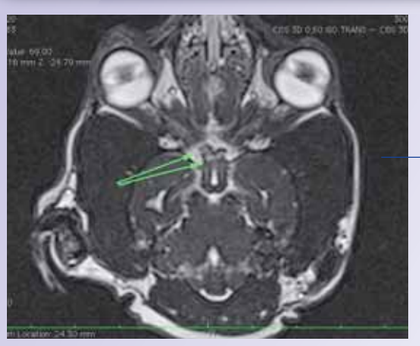


Normal dog – 3D-CISS curved MPR reconstruction enabling the visualization of the entire course of both optic nerves.

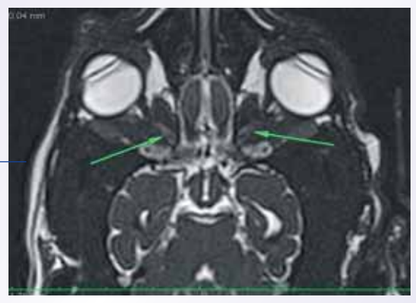


Normal dog – 3D-CISS dorsal reconstruction showing the optic chiasm in a transverse view.

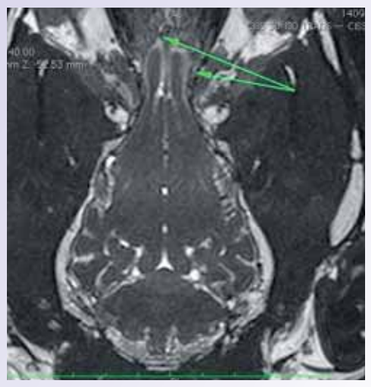
PATHOLOGICAL FINDINGS



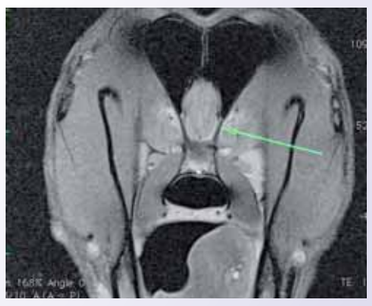
3 years-old female Yorkshire Terrier with an ocular from of GME. 3D-CISS in dorsal view.
Hyperintensities and alterations in the contour and size of the optic chiasm, particularly on the right side (arrows). These lesions were not visible in conventional 2D TSE sequences.



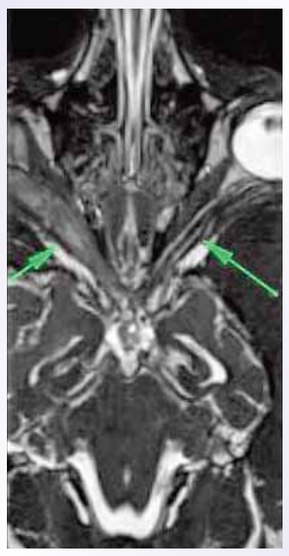
3 years-old Bichon frisé with subacute vision loss 6 months ago. Ophthlamic
examination, results of biological analyses and electroretinogram and optic pathways compatible with SARD. Dorsal view showing significant atrophy of both optic nerves (arrows).



Ten years-old male Berger de Beauce with optic neuritis and meningitis. 3D-CISS dorsal view showing fuzzy and slightly increased thickness of the meninges surrounding olfactif protuberance on both sides (arrows).

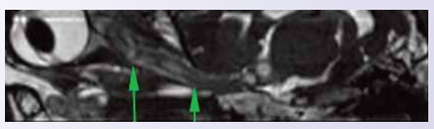


Same dog – Axial 2D T1 weighted TSE with fat saturation and after gadolinium chelate injection showing the slight meningeal enhancement particularly on the left side of the olfactif protuberance (arrow).

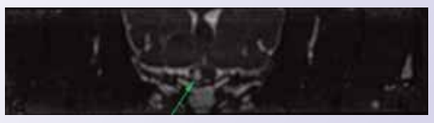


6 years-old female American Stafforshire Terrier with severe right optic neuritis. Enlargment and increased signal intensity of the right optic nerve in its entirety and the right side of the optic chiasm. Dorsal view.

Same dog as above, axial reconstructed view of both optic nerves showing loss of the normal image of the right optic nerve, overall increased signal intensity.



Same dog as above, sagittal curved reconstructed view of the right optic nerve showing increased thickness and signal intensity.



Same dog, axial reconstructed view showing enlargement and hyperintensity of the right side of the optic chiasm.

DISCUSSION / CONCLUSION

Lesions of the/or involving the optic nerves and optic chiasm, e.g. inflammatory (4,5) and neoplastic (1,2) have been diagnosed in small animal patients using MRI. In theses reported cases, lesions were fairly large sized and easily detected with conventional TSE sequences.

In Humans, MR has almost completely replaced CT as the diagnostic modality of choice for investigating optic nerve impairment. High resolution MR studies with conventional TSE sequences (T1 weighted before and after Gadolinium chelates injection, T2 weighted with and without fat saturation, STIR, FLAIR…) and dedicated 3D-CISS sequences allow recognition of a multitude of pathologic conditions (3,6), encompassing congenital anomalies, degenerative/toxic/nutritional neuropathies, inflammatory and infectious lesions, neoplastic lesions, vascular conditions, and trauma.

The challenge of optic pathway imaging consists in performing high resolution studies with small field of view, covering the entire brain while keeping the examination in a reasonable time frame and this requires high field strength technology.

We described usefulness of 3D-CISS sequence for high resolution imaging of optic nerves and chiasm in the dog. We confirmed, as it has been described in Humans, an excellent nerve-CSF contrast, an excellent spatial resolution due to very thin (1 mm or thinner) slices and excellent multiplanar or curved reconstructions in any plane, adequately adapted to the course of the nerves.

In our study, early pathologic processes or small lesions involving optic nerves and chiasm have been detected using 3D-CISS.

Added to conventional TSE sequences, 3D-CISS sequence will probably allow the same diagnostic efficiency as in Humans in recognition of a multitude of optic pathways pathologic conditions.

REFERENCES:

1. Seruca C., Rodenas S., Leiva M., Pena T., Anor S. Acute postretinal blindness: ophthalmologic, neurologic, and magnetic resonance imaging findings in dogs and cats (seven cases) *Veterinary Ophthalmology* 13 (2010) 307-314.
2. Grahn.B.H., Stewart W.A., Twoner R.A., Noseworthy M.D. Magnetic resonance imaging of the canine and feline eye, orbit and optic nerves and its clinical application. *Canadian Veterinary Journal* 34 (1993) 418- 424
3. Held.P., Nitz.W., Seitz.J., Fründ.R., Müller.M., Haffke.T., Hees.H. Comparison of 2D and 3D MRI of optic and oculomotor nerve anatomy. *Journal of Clinical Imaging* 24 (2000) 337-343.
4. Nell.B. Optic neuritis in dogs and cats. *Veterinary Clinics of North America – Small Animal Practice* 38 (2008) 403-415.
5. Talarico L.R., Schatzberg S.J. Idiopathic granulomatous and necrotising inflammatory disorders of the canine central nervous system: a review and future perspectives. *Journal of Small Animal Practice* 51 (2010) 138-149.
6. Becker.M., Masterson.K., Delavelle.J., Viallon.M., Vargas MI., Becker.C.D. Imaging of the optic nerve. *European Journal of Radiology* 74 (2010) 299-313.