DOI: 10.36347/sjams.2017.v05i01.003

Scholars Journal of Applied Medical Sciences (SJAMS) **ISSN 2320-6691 (Online)**
Sch. J. App. Med. Sci., 2017; 5(1A):10-15 **ISSN 2347-954X (Print)**

(An International Publisher for Academic and Scientific Resources)
www.saspublishers.com

Original Research Article

Using the resonance in the evaluation of Wallstent in patients with carotid disease at the National Institute of Neurology and Neurosurgery, México DF. Initial experience

Marco Zenteno Castellanos[1]*, Jorge Balderrama[1], Alejandro Rojas-Marroquín[1], Rodolfo Zavaleta Antúnez[1], Juan, Manuel Santana López[1], José Alejandro Flórez-Cardona[1]

[1] Universidad Nacional Autónoma de México, School of Medicine, National Institute of Neurology and Neurosurgery, Department of Neurological Endovascular Therapy

***Corresponding author**
Marco Zenteno
Email: alejorojasm@gmail.com

Abstract: Our goal is to determine the behavior of the stent in the artery wall by resonance. To describe the presence or absence of intra-stent stenosis using 3D TOF sequence of high resolution and fluoro-resonance and to create a protocol using MRI to allow monitoring of the carotid stent. Currently in the study of intra-arterial devices (STENT) there are sequences for observing such devices. However, it is possible to establish appropriate planning for the study of these structures which also evaluate the inside of the stent and provide information which allows us to quantitatively measure the presence or absence of intra stent stenosis or occlusion. The purpose of this research is to find whether the angiographic sequences 3D TOF high resolution and fluoresonance can be useful to demonstrate the above characteristics. Although the diagnosis of these diseases is based on clinical and ultrasound studies that until now have proven effective, this imaging method will enable timely diagnosis help form; included as part of the study methodology and monitoring, since even when the ultrasound is very efficient in the study and monitoring of these devices not without the limitation of requiring highly skilled personnel for its performance and interpretation.
Keywords: Magnetic Resonance imaging, wallstent, carotid disease.

INTRODUCTION

Stent placement in the carotid artery (CAS) is a therapeutic measure widely used currently for the prevention of cerebrovascular events in patients with symptomatic carotid stenosis or high grade stenosis. To evaluate the effectiveness of treatment and reliable detection of complications such as restenosis or occlusion of the vessel it is required adequate imaging follow.

Options include Doppler ultrasound, digital subtraction angiography (DSA), the angio tomography (CTA) and magnetic resonance angiography (MRA). However, there are some limitations such as the use of ionizing radiation in the DSA and CTA. Ultrasound is operator-dependent and can offer limited reproducibility. In comparison, the magnetic resonance through angiography sequences offers the advantage of being non-invasive and free of ionizing radiation which is a promising option for imaging monitoring. Nevertheless, stent-related artifacts condition a constraint for use. Studies have been made previously to improve the spatial resolution by using dye which demonstrated intra-stent lumen at different field strengths [1-9]. Despite these changes, artifacts related stent give the impression of narrowing the light and the signal is limited to visibility in the light attenuation of the stent. Angiographic sequence time of flight (TOF) is a type of sequence and widely used to represent the intra and extra cranial vascular structures which do not require the use of contrast agents. To date, there are no clear guidelines for effective monitoring exams in carotid stenting [10-13].

To help develop standard protocols for monitoring image by this method, different modes should be compared objectively regarding stent lumen, signal attenuation in the stent and the artifice related devices. Previous studies on the images of the stent used MRA, CTA and DSA [14, 15]. To our knowledge, there are only a few studies to date that systematically analyze artifacts and visibility of the stent with three-

dimensional (3D-TOF) angiographic sequences. However, there are not researches showing the superiority of volumetric sequences with direct visualization of the step of medium contrast through the stent, and the versatility and improvement of 3D-TOF high resolution sequence as currently with MRI coils and high field surface, powerful tools that have been developed to reduce the time acquisition and improve image quality [16-18]. This helps to overcome the weaknesses that cause minimal angiographic sequences, so that both sequences are a promising protocol study of carotid stent using contrast medium or not. The purpose of this study was to determine the effectiveness and reliability of 3D-TOF high-resolution sequence and sequences with fluoresonance in the representation of the stent lumen and vessel characteristics.

METHODOLOGY:

A prospective, observational and descriptive cases study was conducted from 1st March to 30th June 2013 which included a total of 5 patients attending a checkup for monitoring carotid stent. These patients had previous carotid disease prior the wallstent placement. The age range was between 45-65 years old; (55 years average age) which underwent MRI study for the application of 3D TOF angiographic sequences and high resolution and fluoresonance, prior informed consent, normal creatinine values and willing to participate in the study. All images obtained were analyzed in an advanced workstation in three-dimensionally and MIP raw device for analysis and compared with ultrasound studies were performed the same day as the MRI was performed obtaining representative images of both methods. For the systematization and analysis of the information a database in Excel was created in which the caliber of the lumen is included inside the stent and comparative table regarding ultrasound measurements. Images are compared.

RESULTS

A total of 5 patients with a history of atherosclerotic disease with carotid stenosis were studied and whose treatment was stenting (Wallstent) with an age range between 45 - 65 years old; (55 years old average age), all males in the period between March to June 2013, which underwent ultrasound study as a follow carotid device and PIC agreed to participate in this protocol magnetic resonance application of angiographic sequences with and without contrast.

Concentration table was performed **(see annex 1)** in relation to the findings in studies by ultrasound and compared with magnetic resonance imaging studies for both sequences. In our study, all patients were male, the average age was 54.4 years, 60% of patients had the stent in the right internal carotid artery, and 20% in the left internal carotid artery and 20% had bilateral localization. **See figure 1.**

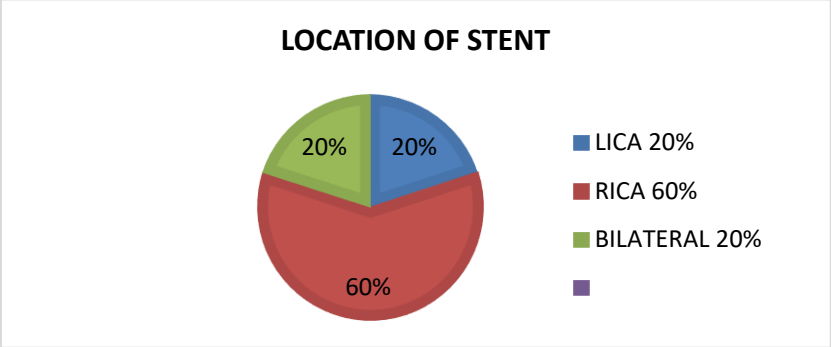

Fig 1: RICA: Right internal carotid artery. LICA: Left internal carotid artery. BILATERAL: RICA (right internal carotid artery) + LICA (Left internal carotid artery).

In 100% of patients the stent was visualized in the resonance angiographic sequences and in the 80% the intra stent lumen was observed properly. In 3D TOF sequence artifice into the stent was minimal in the 80% of patients, while in the fluoresonance sequence in 80% of patients there was no artifact inside the stent. On the other hand, it was reported that there is a correlation with both sonographic and resonance images regarding the reduction of vessel size and location of the intra stent hyperplasia. **See figures 2 and 3**.

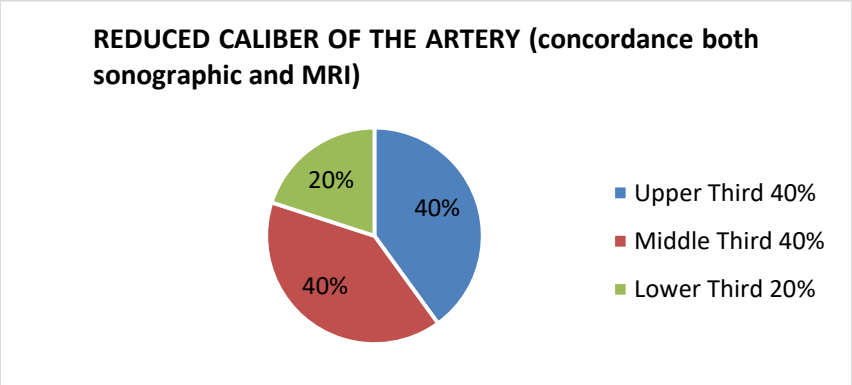

Fig 2: Reduced caliber of the artery 40% in the upper third, 40% in the middle third and 20% in the lower third

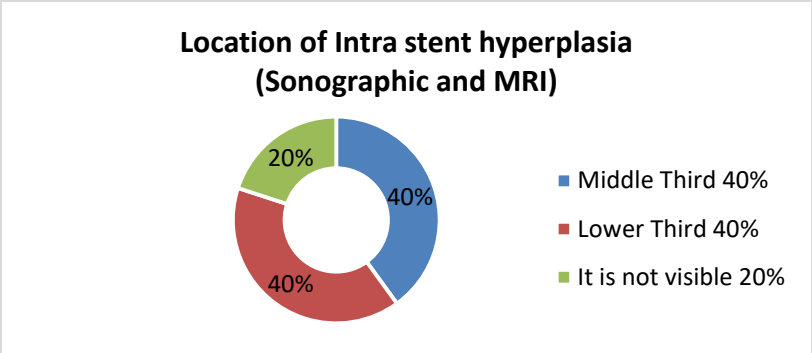

Fig 3: Location of Intra stent hyperplasia Sonographic and MRI, Middle third and lower 40% each and 20% hyperplasia site is not displayed or sonographic or MRI.

DISCUSSION

The 2 major types of artifacts related to the stent are: Susceptibility and Radio frequency (RF). Susceptibility related to artifacts is caused by the type of material of the stent and the tissue around the stent. The radio frequency is produced by the stent struts. The degree of artifact and subsequent changes in the visibility of the intra lumen stent depend on the type of stent, its size and sequences used. However, the influence of a complex geometry of the stent on the artifact produced by it is difficult to predict.

The development of specific guidelines for carotid stenting imaging follow may be a beneficial approach to overcome this problem. To develop image standard guidelines, different types of sequences MRA are necessary to be compared with other imaging modalities available. Monitoring for imaging, MRA has the advantage of including visualizing the brain parenchyma. The disadvantage of angio resonance includes the relatively high cost as well as limited availability. This study was conducted live so it has not the limitations of in vitro studies in which the vessel geometry and flow patterns differ from the live conditions. MRI studies are very useful for visualizing the intra-arterial devices (stent). The volumetric sequences SPGR allowed us to define the environment of the stent and planning's of the study with high definition stent. **(See Figure 4).**

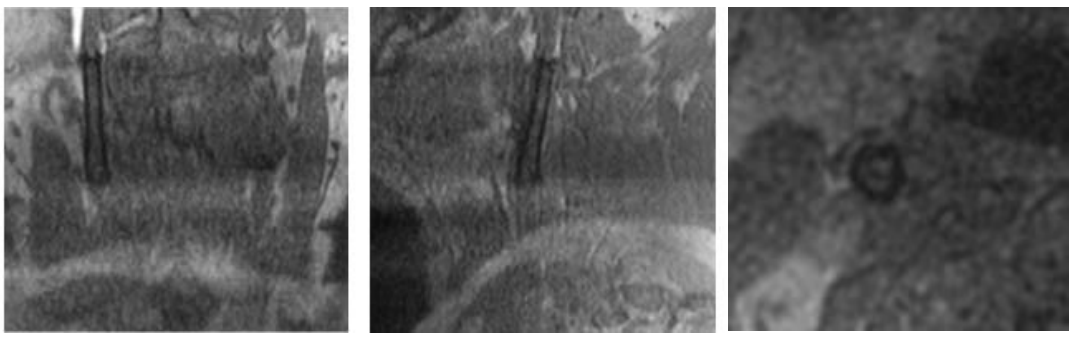

Fig 4: SPGR sequence in coronal plane (a), sagittal (b) and axial (c) allowing the visualization of the stent and its environment for planning simple and contrasted angiographic sequences.

The 3D TOF sequences with the modification to a high resolution with voxel dimensions 0.9 mm, provided the characterization of the stent both externally and internally. (**See Figure 5**)

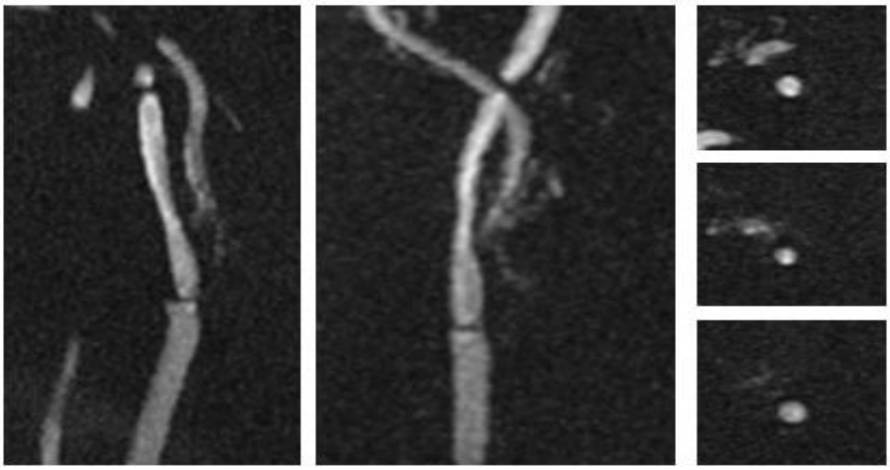

Fig 5: sequence 3DTOF carotid sagittal plane (a), coronal (b) and axial in the upper third, middle third and lower third (c),

Which shows reduction zone caliber in the middle third, in the axial plane the portion is Central stent with greater signal strength and sides of endothelial hyperplasia with lesser intensity. The fluoresonance sequence allowed us to display intra stent lumen with minimal artifice **(See figure 6).**

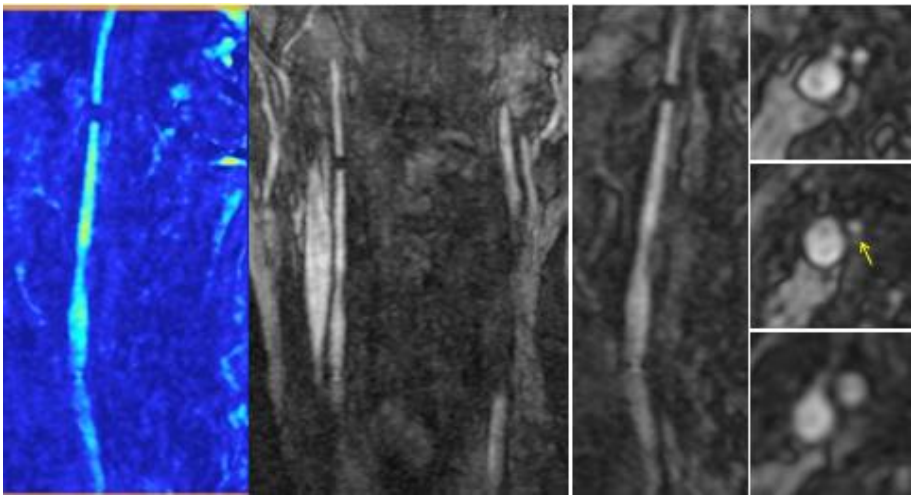

Fig 6: Densitometric fluoro resonance sequence (a), coronal (b), sagittal (c) and axial planes of the upper third, middle third and lower third of the stent.

Decreased lumen of the stent was observed at the junction of the lower third with the middle third secondary to the presence of calcified plaque associated with endothelial hyperplasia. Briefly, the sequences used in this study allowed us to characterize the stent and flow visualization inside the same with minimal artifact probably better definition than ultrasound. However, complementary studies and lines of research will be needed to compare these imaging methods.

CONCLUSION

MRI studies are very useful for visualizing the intra- arterial (stent) devices leaving aside the myth that was with respect to such devices. Although its composition is stainless steel, in the studies, changes were not observed in relation to movement or displacement. Likewise, patients did not experience any change in relation to temperature or pain reference at the stent site at any time of the study. The volumetric SPGR sequences allowed us to define the environment of the stent and planning's of the study with high definition stent. The 3D TOF sequence is the most often used for the characterization of the arterial structures.

However, as described in some publications the artifice which condition this sequence in the

presence of carotid device does not allow adequate visualization of the interior of the stent. Nevertheless, to make the modification of a conventional sequence of high-resolution 0.9mm voxel size provides characterization of the stent and allows the evaluation of the inside stent very precisely. On the other hand, fluoresonance sequence allows flow visualization inside the stent with minimal artifact on the light device which makes even more accurate characterization. So, the sequences used allowed us to characterize the stent as well as the inside it accurately probably more effective than ultrasound. Although this will require a research to compare methods used to follow up these devices. Whereby, it appears to be a promising method for monitoring the carotid stent.

Acknowledgments:

The authors express their gratitude to **Fernando Iturbe** radiographer by images processing to publish this article.

REFERENCES

1. Fisher CM. Occlusion of the internal carotid artery. Arch Neurol Psychiatry.1951; 65:346- 377.
2. Estol CJ. Dr C. Miller Fisher and the history of carotid artery disease. Stroke. 1996 Mar 1; 27(3):559-66.
3. Fields WS. The history of carotid endarterectomy. Rev Neurol Argent.1991; 16:20 -28.
4. U-King-Im JM, Young V, Gillard JH. Carotid-artery imaging in the diagnosis and management of patients at risk of stroke. The Lancet Neurology. 2009 Jun 30; 8(6):569-80.
5. Baquis GD, Pessin MS, Scott RM. Limb shaking--a carotid TIA. Stroke. 1985 May 1; 16(3):444-8.
6. Final results of the North American Symptomatic Carotid Endarterectomy Trial (NASCET). Stroke 1998;29:286
7. Barnett HJ, Taylor DW, Eliasziw M, Fox AJ, Ferguson GG, Haynes RB, Rankin RN, Clagett GP, Hachinski VC, Sackett DL, Thorpe KE. North American Symptomatic Carotid Endarterectomy Trial Collaborators. Benefit of carotid endarterectomy in patients with symptomatic moderate or severe stenosis. N Engl J Med. 1998; 339(20):1415-25.
8. Brown MM, Rogers J, Bland JM. Endovascular versus surgical treatment in patients with carotid stenosis in the Carotid and Vertebral Artery Transluminal Angioplasty Study (CAVATAS): a randomised trial. The Lancet. 2001 Jun 2; 357(9270):1729-37.
9. Johnson MB, Wilkinson ID, Wattam J, Venables GS, Griffiths PD. Comparison of Doppler ultrasound, magnetic resonance angiographic techniques and catheter angiography in evaluation of carotid stenosis. Clinical radiology. 2000 Dec 31; 55(12):912-20.
10. Wardlaw JM, Chappell FM, Best JJ, Wartolowska K, Berry E. Non-invasive imaging compared with intra-arterial angiography in the diagnosis of symptomatic carotid stenosis: a meta-analysis. The Lancet. 2006 May 12; 367(9521):1503-12.
11. Blum MB, Schmook M, Schernthaner R, Edelhauser G, Puchner S, Lammer J, Funovics MA. Quantification and detectability of in-stent stenosis with CT angiography and MR angiography in arterial stents in vitro. American Journal of Roentgenology. 2007 Nov; 189(5):1238-42.
12. Borisch I, Hamer OW, Zorger N, Feuerbach S, Link J. In vivo evaluation of the carotid Wallstent on three-dimensional contrast material–enhanced MR angiography: influence of artifacts on the visibility of stent lumina. Journal of vascular and interventional radiology. 2005 May 31; 16(5):669-77.
13. Hagspiel KD, Leung DA, Nandalur KR, Angle JF, Dulai HS, Spinosa DJ, Matsumoto AH, Christopher JM, Ahmed H, Berr SS. Contrast-enhanced MR angiography at 1.5 T after implantation of platinum stents: in vitro and in vivo comparison with conventional stent designs. American Journal of Roentgenology. 2005 Jan; 184(1):288-94.
14. Hähnel S, Nguyen-Trong TH, Rohde S, Hartmann M, Braun C, Sartor K, Heiland S. 3.0 Tesla contrast-enhanced MR angiography of carotid artery stents: in vitro measurements as compared with 1.5 Tesla. Journal of neuroradiology. 2006 Apr 30; 33(2):75-80.
15. Hamer OW, Borisch I, Paetzel C, Nitz WR, Seitz J, Feuerbach S, Zorger N. In vitro evaluation of stent patency and in-stent stenoses in 10 metallic stents using MR angiography. The British journal of radiology. 2014 Jan 28.
16. Klemm T, Duda S, Machann J, Seekamp-Rahn K, Schnieder L, Claussen CD, Schick F. MR imaging in the presence of vascular stents: a systematic assessment of artifacts for various stent orientations, sequence types, and field strengths. Journal of Magnetic Resonance Imaging. 2000 Oct 1; 12(4):606-15.
17. Wang Y, Truong TN, Yen C, Bilecen D, Watts R, Trost DW, Prince MR. Quantitative evaluation of susceptibility and shielding effects of nitinol, platinum, cobalt-alloy, and stainless steel stents. Magnetic resonance in medicine. 2003 May 1; 49(5):972-6.
18. Lettau M, Sauer A, Heiland S, Rohde S, Bendszus M, Hähnel S. Carotid artery stents: in vitro comparison of different stent designs and sizes using CT angiography and contrast-enhanced MR angiography at 1.5 T and 3T. American Journal of Neuroradiology. 2009 Nov 1; 30(10):1993-7.

Annex 1:

Findings	**Patients/ Sex / Age**				
	1/Male/65 years	2/Male/47 years	3/Male/59 years	4/Male/45 years	5/Male/56 years
Location of the Stent					
US	RICA	LICA	RICA-LICA	RICA	RICA
MRI	RICA	LICA	RICA-LICA	RICA	RICA
MRI					
Visualization of Stent					
SPGR Sequence	Yes	Yes	Yes	Yes	Yes
Visualization of Intra Stent					
Lumen	Yes	Yes	Yes	Yes	Not
3DTOF sequence					
artifice intrastent	Minimum	Minimum	Minimum	Minimum	Moderate
Fluororesonance sequence					
artifice intra stent	None	None	None	None	Moderate
Reduced caliber of the artery					
US	Middle Third	Upper Third	Middle Third	Lower Third	Upper Third
MRI	Middle Third	Upper Third	Middle Third	Lower Third	Upper Third
Location					
of Intra stent hyperplasia					
US	Middle Third	Lower Third	Middle/Lower	Lower Third	Not displayed
MRI	Middle Third	Lower Third	Middle/Lower	Lower Third	Not displayed

Annex 1: Summary of stent findings (Wallstent) in MRI and Sonographic imaging (US)