

**THE CHALLENGES OF RUNNING MAGNETIC RESONANCE IMAGING SERVICES IN THE TERTIARY HEALTH CENTERS OF NIGERIA**

---

<sup>1</sup>SAIDU SA, <sup>2</sup>UMAR FK

---

<sup>1</sup>Department of Radiology, Faculty of Clinical Sciences, College of Health Sciences, Usmanu Danfodio University, Sokoto. <sup>2</sup>Department of Radiology, Usmanu Danfodiyo University Teaching Hospital, Sokoto.

**Correspondence and reprint request to: SAIDU S.A,**  
Department of Radiology, Faculty of Clinical Sciences, College of Health Sciences,  
Usmanu Danfodio University, Sokoto  
**eMail:- [sulesaidu@gmail.com](mailto:sulesaidu@gmail.com); [sulesaidu@yahoo.com](mailto:sulesaidu@yahoo.com)**

---

**ABSTRACT**

---

**Background:** The field of diagnostic radiology has emerged and expanded to become an integral part of healthcare worldwide. Nigeria, as a country is keeping pace with the global trend. Magnetic resonance imaging (MRI) is now becoming standard clinical care in many tertiary health centers of Nigeria. The technique has great advantages and some setbacks in a country like Nigeria. Here, we review some of the challenges involved in the practice of MRI, including recommendations on the way forward for overall advancement of MRI services in the country.

**Method:** Literature search were done using keywords described above on Medline, PubMed, HINARI and Advanced Google search. Relevant articles were pooled and information was extracted and appropriately referenced. Books and Journal hardcopies were also obtained from the Library of Usmanu Danfodiyo University Teaching Hospital, Sokoto. These were referenced accordingly.

**Results:** The introduction of MRI as a radiological modality in Nigeria revolutionized the field of medicine. MRI gives different, reliable, safer and superior information when compared with X-rays (radiography) and computed tomography (CT) scans especially as regards soft tissue differentiation. The foremost challenges of MRI in Nigeria are; high economic cost, poor power supply issues and technical maintenance.

**Conclusion:** We recommend a multi stakeholder approach in areas of procurement, installation, training and maintenance of MRI machine. The national health insurance scheme and other hospital based welfare schemes should be expanded to significantly accommodate high cost investigations like the MRI.

---

**Keywords:** *MRI, Challenges, Nigeria*

**INTRODUCTION**

The description of the factors leading to image contrast had been described around the early 1950s by Erik Odeblad,<sup>1</sup> however, the magnetic resonance imaging (MRI) machine as we know it today was not invented until in the early 1970s by Paul C. Lauterbur.<sup>2</sup> MRI scanners are expensive to acquire and have relatively high ongoing operating cost.<sup>3</sup> Consequently, MRI may simply be described as the most expensive radiological/ hospital

investigation. The MRI machine uses strong pulses of magnetic fields, radio waves and field gradients to obtain images of organs and structures inside the body that are useful in health and disease.<sup>4</sup> However, MRI does not use ionizing radiation hence it is usually preferred when the same information can be obtained using other modalities e.g. computed tomography (CT) scan.<sup>5</sup> When using MRI machine, the area of the body being studied is placed inside a special

machine that contains a strong magnet. Images from an MRI scan are digital in nature and can be saved and stored on a computer for more study. The images can also be reviewed remotely, such as in a clinic or an operating room as part of Radiological or Hospital Information System (RIS or HIS). In some cases, contrast may be used during the MRI scan to delineate some structures more clearly.<sup>6</sup>

MRI requires a magnetic field that is both strong and uniform. The field strength of the magnet is measured in tesla (T). Based on this, there are two types of MRI machines; low field strength, 0.1- 1.0T (open) and high field strength, greater than 1.0T (closed). However, most machines in the world are in the range of 0.5-3.0T.<sup>7</sup> MRI is invaluable in defining lesions of the spine, brain, joint and (with high T) abdomen and breast.<sup>5</sup>

#### THE USE OF MRI IN DIAGNOSTIC RADIOLOGY IN NIGERIA

The practice of radiology as a specialty in Nigeria commenced with the establishment of the Faculty of Radiology in the National Postgraduate Medical College of Nigeria (NPMCN) in 1979 and West African College of Surgeons (WACS) in 1989.<sup>8,9</sup> The first Consultant Radiologist was produced in May 1980 by the NPMCN.<sup>10</sup> The practice of Radiology in Nigeria has transformed and advanced rapidly over the past few years. X-ray machines used to be the only investigations available in the early 1980s. Ultrasound machines entered the field in the late 1990s. Ultrasonography is particularly useful in imaging soft tissues that may otherwise not be demonstrated by the X-rays.<sup>10</sup> Computed tomography (CT) is an imaging technique introduced in the early 1970s but was not utilized in the country till in the late 1990s. The CT uses a special X-ray machine to obtain images from different angles of the body.

In Nigeria the use of MRI in medicine and health began in the early 2000s with the introduction of the VAMED project on the rehabilitation of the federal University Teaching Hospitals by the Federal Government of Nigeria.<sup>10</sup> All the machines purchased under this programme were however low Tesla MRI machines presumably because of the exorbitant cost of the higher Tesla machines. The snag is that the low Tesla machines are of lower



Image of a 0.2T MRI machine in a Nigerian University Teaching Hospital

resolution and much less efficient in performing complex examinations such as diffusion weighted and perfusion weighted imaging (DWI and PWI) as well as magnetic resonance spectroscopy (MRS) which are important in the diagnosis and assessment of some disease processes.<sup>11-13</sup> Proper examination of the breasts and abdomen can also only be undertaken with the higher Tesla machines.<sup>14-15</sup> The good news is that a few private facilities have, of recent, been setting up higher Tesla machines in Lagos and Abuja. Most of the latter are not new but refurbished old machines imported from Europe and the USA. This is because of the prohibitive cost of new high Tesla MRI machines. Importing such new high Tesla machines would translate into unimaginable initial cost resulting in unbearable cost of the examinations for the patients, which most will not be able to afford thus making such centres unviable. Whether in the long run the maintenance cost and reduced longevity of such refurbished machines currently installed by the centres will be an advantage, only time will tell.

## THE CHALLENGES OF RUNNING MRI IN NIGERIA

The challenges to running effective MRI services in Nigeria can be summarized in the outline below;

*Cost:* The cost can be categorized broadly into two; cost incurred by the government/hospital management and cost incurred by the patients. The costs incurred by the government/hospital management are related to the procurement and installation of machine. There are also issues with provision of the basic infrastructure necessary for accommodating the machine. The quality of power supply from the National grid, with frequent fluctuation and light outs is inimical to the MRI machine and regular MRI service. Consequently, a dedicated power supply by way of generating sets is mandatory. Centers are therefore left with no choice but to procure diesel, usually at exorbitant black market prices. There is also the problem with maintenance cost as engineers and machine parts often have to be flown in from overseas for any issue or problem encountered with the machine, as most of the ones in Nigeria are not as competent. To the best of the knowledge of the authors, there is no centre in Nigeria that has more than one MRI machine, meaning that no back up facility is available in any centre in the event of a break down. Consumables for the MRI machine like Gadolinium are not readily available and when needed often have to be procured from outside the country or far away in Lagos or Abuja.

Additionally, invariably patients bear the cost of this investigation due to the unavailability of an efficient nationwide patient support and welfare, as well as the fact that ours is more an out-of-pocket system. The burden is even more precarious bearing in mind that more than 70% of Nigerians live on less than \$1.00 a day.<sup>16</sup> The National health insurance scheme (NHIS) which would ordinarily have been a panacea had for a long time not accommodated MRI.<sup>17</sup> It was only after a lot of advocacy that at present MRI services are accepted for up to 50% support by the Health Maintenance Organizations (HMO).<sup>18</sup>

*Resolution:* Low Tesla MRI machines are relatively much less expensive, but of lower resolution or image quality. The latter effect is thought to be mainly brought about because of the longer time

required for image acquisition which increases the chances of patient-induced motional artefacts.<sup>12,19</sup> Unfortunately, most of the MRI machines in Nigeria are low Tesla. This may eventually affect patient care especially if surgery is needed with the attendant medico-legal implication.<sup>20</sup> This is also thought to be the reason for its application being limited to few anatomical regions mainly brain and spine.<sup>21</sup>

*Drawbacks:* MRI is not good for diagnosis of bone lesions e.g. fractures, bony involvement by lesions, diagnosis of subarachnoid hemorrhage and intracranial air. There are also compatibility/logistic problems in performing MRI on trauma patients. The use of MRI in patients on ventilators and other monitoring devices is cumbersome and difficult to carry out. All these drawbacks may also have medico-legal and patient care implications.<sup>22</sup>

*Time:* Low tesla machines require lots of time to be able to produce images of diagnostic quality. More man hours are required with fewer cases per time (high Tesla machines are more efficient).<sup>23</sup>

*Security:* Most multinationals have blacklisted Northern Nigeria because of the Boko Haram crisis that started in the year 2009/2010 therefore making request for repairs, when the need arise, not promptly attended to.

*Distance:* The MRI machines in Nigeria are available at only few referral centers that are usually far away from neighboring states or even from the community they are meant to serve. This makes MRI services particularly inaccessible. The poor situation of the road network also appears to complicate matters towards patient recovery.

*Knowledge of MRI Technology:* It is believed that the accuracy in MRI interpretation requires technical and interpretation skills which can vary with the level of training and the type of equipment.<sup>21</sup> It is noteworthy, however, that in this environment many of the MRI machines are procured and installed without sufficient training of the staff to be involved in their application and maintenance radiologists, radiographers and biomedical engineers.

Specialised training and expertise is essential to optimize imaging parameters and provide quality control and accurate interpretation.<sup>22</sup> Some of the centres do not even have dedicated trained MRI engineers. Periods of non-functionality and machines down times are usually due to the lack of adequate technical support and/or service materials.<sup>21</sup>

### RECOMMENDATIONS

We recommend the collaboration of all stakeholders in health to overcome these challenges noted above. Additionally, there should be more advocacy by radiologists and other relevant stakeholders to Government, power brokers, multinationals, non-governmental organizations and philanthropists to attract more funds for MRI machines. At least one high field (1.5-3.0T) MRI machine should be provided per state to reduce patient burden and improve quality of imaging and care, while one low Tesla machine should be made available per senatorial district. The complex cases that may require higher Tesla machine for proper assessment can thus be taken care of. Government should increase resource allocation to health up to 15% of gross domestic product (GDP) as recommended by the World Health Organization (WHO) and the African Union (AU) to make more resources available to tackle the issues of funding for healthcare services and equipment. The scope of the National Health Insurance Scheme (NHIS) introduced into the country in 2003 should also be broadened to significantly support high cost investigations like the MRI. The community based social health insurance program should be expedited and extended to cater for the informal sector. Friends of the Hospital initiatives/platform should be established in all the health centers of Nigeria to cater for the less privileged patients that cannot afford MRI service fees. Hospital management should create patient welfare committees (if not already existing) to oversee patient categorization and assistance. Religious and other philanthropic organisations should be mobilized to come to the aid of the patients, where necessary. Local, State and Federal Governments as well as the traditional institutions should collaborate with well-meaning individuals to establish endowment funds to assist indigent patients.

The purchase and installation of MRI machines should immediately be accompanied by intensive on-site training for all those to be involved in its application on patients. More specialized training should be ensured at regional centres so designated or even abroad. This would ensure that patients get the best from such machines while also getting value for their money and also to reduce machine down times. Centres providing MRI services should be encouraged to employ, train and retain dedicated MRI engineers and where possible to have more than one machine thus ensuring backup in the event of breakdown of one of such machines.

### CONCLUSION

Magnetic resonance imaging (MRI) is now becoming standard clinical care in many tertiary health centers of Nigeria. The technique has great advantages and some challenges in a country like Nigeria. The main challenges of MRI in Nigeria are; high cost of procurement, installation and maintenance which hinder even and adequate distribution of the machines as well as affordability for patients; poor power supply issues and technical maintenance. We recommend a multi stakeholder approach in areas of procurement, installation, training and maintenance of MRI machines as well as advocacy for the provision of more of such machines across the country. The provision of some high Tesla MRI machines for the proper assessment of complex diseases that may not be possible with the low Tesla machines should also be ensured. The NHIS and other social welfare measures should be intensified and broadened to make the modality more affordable especially for indigent patients.

## REFERENCES

1. Rinck PA (2014). "The history of MRI". *Magnetic Resonance in Medicine (8th edition)*.
2. Lauterbur PC. "Image Formation by Induced Local Interactions: Examples of Employing Nuclear Magnetic Resonance". *Nature* 1973 **242** (5394): 190-1. Available from [Bibcode: 1973Natur.242.190L](#). doi: [10.1038/242190a0](#). (Accessed 04/04/2016).
3. Kowal DJ. Magnetic Resonance Imaging: Understanding the principles and recognizing the basics. In Herring W(ed). *Learning Radiology*. 2<sup>nd</sup> ed. Saunders, Elsevier. 2012;209-217.
4. Chernecky CC, Berger BJ (2013). *Laboratory Tests and Diagnostic Procedures*, 6th ed. St. Louis: Saunders.
5. Pretorius ES, Solomon JA (ed.). *Radiology*. 2<sup>nd</sup> ed. Philadelphia; Mosby. 2006.
6. Fischbach FT, Dunning MB III, eds. (2009). *Manual of Laboratory and Diagnostic Tests*, 8th ed. Philadelphia: Lippincott Williams and Wilkins.
7. Magee T, Shapiro M, Williams D. Comparison of high field- strength versus low field- Strength MRI of the shoulder. *AJR*2003; **181**(5): 1211-1215.
8. National Postgraduate Medical College of Nigeria. Faculty of radiology curriculum and guidelines; a handbook for residents and their teachers, Revised 2013, NPMCN Publishers, Lagos. 2013;14-28.
9. West African College of Surgeons, (WASC website) . Available from <http://www.wascoac.org/index.php/accredited-institutions#radiology>. (Accessed on 07/04/2016).
10. Nzeh D, Obajimi M, Sackey T, Akinlade A (Eds). *Fundamentals of Radiologic Physics*. First edition, Book builders: Ibadan, 2015.
11. Gillard JH, Waldman AD, Barker PB. (Eds). *Clinical MR Neuroimaging: Diffusion, Perfusion, and Spectroscopy*. 1<sup>st</sup> ed. Cambridge Press. 2005:1-3.
12. Terada H, Gomi T, Harada H, Chiba T, Nakamura T, Iwabubuchi S, et al. Development of diffusion weighted image using a 0.3T open MRI. *J Neuroradiol*. 2006; **33**:57-61.
13. Okorie CK, Ogbole GI, Owolabi MO, Ogun O, Adeyinka A, Ogunniyi A. Magnetic Resonance Imaging in Resource-limited Settings. *West Afr J Radiol* 2015; **22**(2): 61-66.
14. Semella RC. *Abdominal-Pelvic MRI*. 3<sup>rd</sup> ed. Wiley- Blackwell. 2010.
15. Raza S, Birdwell RL, Ritner JA, Yeh E, Gombus E, Wang S, et al. *Specialty Imaging: Breast Imaging: A Comprehensive Imaging Guide*. Amirsys. 2010.
16. Unicef.org/wcaro/countries\_1320html. (Accessed 26/6/2016, 20:00 hours)
17. National health insurance scheme. Operational guidelines. 2005;9-12.
18. [http://nhis.gov.ng/file/repository/NHIS\\_OPE\\_RATIONAL\\_GUIDELINES.pdf](http://nhis.gov.ng/file/repository/NHIS_OPE_RATIONAL_GUIDELINES.pdf) (Accessed 27/06/2016 at 22:00 hours).
19. Mehdizade A, Somon T, Wetzel S, Kelekis A, Martin JB, Scheidegger JR, et al. Diffusion weighted MR imaging on a low-field open magnet. Comparison with findings at 1.5T in 18 patients with cerebral ischemia. *J Neuroradiol*. 2003; **30**:25-30.
20. Hayashi N, Watanabe T, Masumoto T, Mori H, Aoki S, Ohtomo K, Okitsu O, Takashi T. Utilisation of low field MR scanners. *Mag Reson Med Sci* 2004; **3**(1): 27-38.
21. Ogbole GI, Adeleye AO, Adeyinka A, Ogunseyinde OA. Magnetic Resonance Imaging: Clinical experience with an open low-field-strength scanner in a resource challenged African state. *J Neurosci Rural Pract* 2012; **3**:137-143.
22. Sanal HT, Cardoso F, Chen L, Chung C. Office- based versus high-field strength MRI: diagnostic and technical considerations. *Sports Med Arthrosc* 2009; **17**(1): 31-39.
23. Hailey D. Utilization of low- field MR scanners. *Issues Emerg Health Technol* 2006; **92**:1-4.