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Profile of Mri Findings and Neurologic Impairment in Spinal Cord Injury Patients at Lagos University Teaching Hospital, Nigeria

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Abstract: The aim of this study was to describe the pattern of spinal cord injuries, MRI signal patterns and neurological impairment among spinal cord injury patients in Lagos, Nigeria. A retrospective study of the hospital records and MRI reports of 90 spinal cord injury patients at the Lagos University Teaching Hospital was conducted. The study included patients who presented at the hospital with spinal cord injury between 2006 and 2012. Results showed young to middle-aged male gender and cervical spinal cord injury preponderances. The dominant etiological factor was road traffic accident (60%, n = 54). In ASIA A class, 22.2% (n = 20) had intramedullary cord hemorrhage only while 31.1% (n = 28) had a combination of intramedullary cord hemorrhage and edema. For ASIA B, 6.7% (n = 6) had intramedullary cord hemorrhage only, 13.3% (n = 12) had cord edema only and 2.2% (n = 2) had a combination of intramedullary cord hemorrhage and edema. ASIA C consisted of 8.9% (n = 8) patients who had cord edema only. ASIA D and E categories also consisted of 11.1% (n = 10) and 4.4% (n = 4) patients respectively who had cord edema only. The relationship between pre-treatment classification, MRI findings and neurological status at the end of treatment was of prognostic value in neurological outcome of the patients. In conclusion this study has revealed the pattern of spinal cord injury lesions at MRI in the locality. The dominant lesions were hemorrhage and a combination of hemorrhage and edema. This lesion pattern showed direct relationship with ASIA classification scale for neurological impairment and thus was useful for prognostication of the injuries.

Key words: Spinal Cord Injury · Magnetic Resonance Imaging · Neurological Impairment

INTRODUCTION

Spinal cord trauma is a major public health concern in Nigeria and other African countries. It refers to trauma affecting the spinal cord either directly or indirectly. The traumatic force could come from a variety of mechanisms but the leading etiological factor identified in Nigerian victims is road traffic accident (RTA) [1-3]. Spinal cord trauma is a major cause of death and disability in young people, affecting predominantly males [4]. It affects mostly the cervical and lumbar segments and most times results in paraplegia and quadriplegia as the main neurological disorders. Spinal injuries from the cervical spine down to the first lumbar vertebrae involve the spinal cord and injuries below the first lumbar vertebrae involve the cauda equina [4].

Spinal cord injuries affect the nervous system and are as such considered to be serious. At the acute phase, spinal cord injury may present with initial spinal shock which is characterized by flaccid paralysis with no reflexes

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or sensation below the level of injury. Spinal shock lasting more than 24 hours is a bad prognostic sign [4]. The victims of spinal cord injury are subjected to very long periods of hospitalization. Survivors end up with serious neurological disorders [2] and high mortality rates in the order of 30% or greater have been reported [1, 4]. Managing the injury is a serious business and imaging has a very vital role to play. Investigative imaging could be by frontal and lateral conventional radiography of the involved segment, computed tomography (CT) or magnetic resonance imaging (MRI). Of these three imaging modalities, MRI is considered the best because it allows better visualization of the spinal cord, ligaments, intervertebral discs, vessels and other soft tissues better than CT and radiography [5]. Magnetic resonance evaluation of anatomic structures can help determine the cause and extent of neurological deficit, the probable mechanism of injury and the presence of spinal instability [6]. With this extent of evaluation possible with MRI, its signal patterns have been used for prognostication of spinal cord injuries. As earlier reported in previous studies, MRI is strongly recommended for the prognostication of acute spinal cord injury and the sagittal T2 image is particularly of immense value in this regard [5].

In this study, we evaluated the pattern of spinal cord injuries and MRI signal patterns for prognostication of spinal cord injuries according to the pattern first described by Kulkarni *et al*. [7]. These signal patterns are based on T2-weighted sagittal images of the spinal cord.

MATERIALS AND METHODS

A retrospective evaluation of hospital records of spinal cord injury patients and MRI findings (signal patterns) was conducted. The patients were spinal cord injury victims who presented at the Lagos University Teaching Hospital, Lagos, Nigeria between 2006 and 2012. The study protocol was approved and permission to conduct was obtained from the hospital. A total of 90 spinal cord injury patients who met the inclusion criteria had their records evaluated. The inclusion criteria were:

- Patient with spinal cord injury who had MRI examination.
- The injury occurred between 2006 and 2012
- Patient with complete hospital records including reports of radiological investigations which must include MRI.

Data were collected by retrieving patients' hospital records and MRI reports from the folders at the medical records archive. MRI reports revealed signal patterns of the injuries such as intramedullary cord hemorrhage, cord edema, a combination of intramedullary cord hemorrhage and edema and normal cord signal. The following useful pieces of information were also retrieved from the folder: etiological factor, spinal segment involved, neurological classification at presentation and upon release from hospital and demographic characteristics such as age and gender. Recovery was classified according the contents of the notes of the attending clinicians as either "complete recovery" or "incomplete recovery".

Data collected were analyzed using commercially available Statgraphics Plus Professional statistical software version 16.0 (www.ircfast.com). Descriptive and inferential statistics were carried out. Inferences were made by test for equality of proportions. Statistical significance was considered at $p < 0.05$.

RESULTS

Figure 1 is bar charts showing the distribution of the patients whose records were evaluated in this study according to gender. Male patients comprised 71.1% (n = 64) of the victims while 28.9% (n = 26) patients were females. They were aged between 20 and 75 years with majority of them (33.3%, n = 30) being between 36 and 45 years as shown in Table 1. The cervical spine segment of the spinal cord was the more involved segment in the injuries (51.1%, n = 46) than the rest of the segments ($p < 0.05$) as shown in Table 2. Most of the injuries (60%, n = 54) were as result of road crashes making RTA the dominant etiological factor of spinal cord injury ($p < 0.05$) as shown in Table 3.

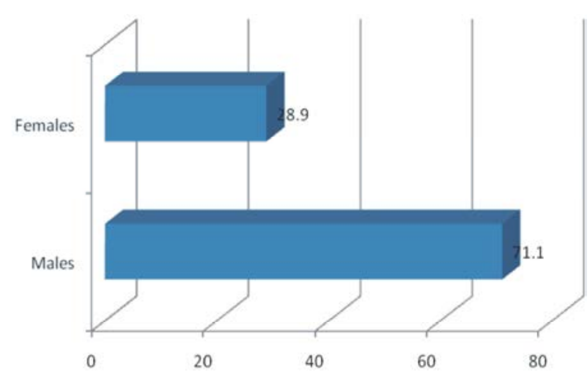

Fig. 1: Bar chart showing gender distribution of spinal cord injury victims in percentages

Table 1: Age distribution of spinal cord injury victims

Age range (years)	Percentage (Frequency)
Less than 25	13.3 (n=12)
26 – 35	11.1 (n=10)
36 – 45	33.3 (n=30)
46 – 55	17.8 (n=16)
56 – 65	11.1 (n=10)
66 – 75	13.3 (n=12)
Total	100 (n=90)

Table 2: Segment of the spine involved in the injury

Spinal Segment	Percentage (Frequency)
Cervical spine	51.1 (n=46)
Thoracic spine	22.2 (n=20)
Lumbar spine	26.7 (n=24)
Total	100 (n=90)

Table 3: Distribution of identified causes of spinal cord injuries

Cause	Percentage (Frequency)
RTA	60.0 (n=54)
Fall from height	22.2 (n=20)
Assault	11.1 (n=10)
Gunshot	6.7 (n=6)
Total	100 (n=90)

Table 4: Distribution of MRI findings according to pre-treatment neurological classification of patients

Neurological Classification	Hemorrhage Only	Edema Only	Hemorrhage and Edema	Neither Hemorrhage nor Edema	Total
ASIA A	22.2% (n=20)	-	31.1% (n=28)	-	53.3%(n=48)
ASIA B	6.7% (n=6)	13.3% (n=12)	2.2% (n=2)	-	22.2% (n=20)
ASIA C	-	8.9% (n=8)	-	-	8.9%(n=8)
ASIA D	-	11.1% (n=10)	-	-	11.1%(n=10)
ASIA E	-	4.4% (n=4)	-	-	4.4%(n=4)
Total	28.9%(n=26)	37.7% (n=34)	33.3% (n=30)	-	100%(n=90)

Table 5: Patient recovery, MRI findings and pre-treatment ASIA neurological classification

	MRI findings and recovery status									
	Hemorrhage Only			Edema Only			Hemorrhage and Edema			
Neurological Classification	Complete	Incomplete	Nil	Complete	Incomplete	Nil	Complete	Incomplete	Nil	Total
ASIA A	-	4	16	-	-	-	-	4	24	53.3%(n=48)
ASIA B	2	-	4	8	4	-	-	2	-	22.2%(n=20)
ASIA C	-	-	-	8	-	-	-	-	-	8.9%(n=8)
ASIA D	-	-	-	10	-	-	--	-	-	11.1%(n=10)
ASIA E	-	-	-	4	-	-		-	-	4.4%(n=4)
Total	2.2%(n=2)	4.4%(n=4)	22.2%(n=20)	33.3%(n=30)	4.4%(n=4)	-	-	6.7%(n=6)	26.7%(n=24)	100%(n=90)

On presentation at the hospital, the victims were classified to indicate their levels of neurological deficit according to the method of American Spinal Injury Association (ASIA) [8]. The pre-treatment neurological classification according to ASIA scale showed that majority of the victims (53.3%, n = 48) were classified as ASIA A, 22.2% (n = 20) as ASIA B, 8.9% (n = 8) as ASIA C, 11.1% (n = 10) as ASIA D and 4.4% (n = 4) as ASIA E as shown Table 4. The distribution of MRI findings according to neurological classification was also shown in Table 4. For ASIA A, 22.2% (n = 20) had intramedullary cord hemorrhage only while 31.1% (n = 28) had a combination of intramedullary cord hemorrhage and edema. For ASIA B, 6.7% (n = 6) had intramedullary cord hemorrhage only, 13.3% (n = 12) had cord edema only and 2.2% (n = 2) had a combination of intramedullary cord hemorrhage and edema. ASIA C consisted of 8.9% (n = 8) patients who had cord edema only. ASIA D and E categories also consisted of 11.1% (n = 10) and 4.4% (n = 4) patients respectively who had cord edema only.

Table 5 shows the pre-treatment neurological classification cross tabulated with MRI findings and recovery status after treatment. ASIA A category had 53.3% (n = 480 patients; 22.2% (n = 20) of who had intramedullary cord hemorrhage only while 31.1% (n = 28) had both intramedullary cord hemorrhage and edema..

Table 6: Post-treatment neurological classification of spinal cord injury victims

Neurological Classification	Percentage (Frequency)
ASIA A	44.4 (n=40)
ASIA B	11.1 (n=10)
ASIA C	4.4 (n=4)
ASIA D	4.4 (n=4)
ASIA E	35.6 (n=32)
Total	100 (n=90)

Only 8.9% (n = 8) in this group achieved incomplete recovery – 4.4% (n = 4) with intramedullary cord hemorrhage and 4.4% (n = 4) with both intramedullary cord hemorrhage and edema while the rest did not recover at all. In ASIA B category, 6.7% (n = 6) had intramedullary cord hemorrhage only and only 2.2% (n = 2) achieved complete recovery, 13.3% (n = 12) had cord edema only with 8.9% (n = 8) achieving complete recovery and 4.4% (n = 4) achieving incomplete recovery. Only 2.2% (n = 2) had a combination of intramedullary cord hemorrhage and edema and both achieved incomplete recovery. In ASIA C category, there were 8.9% (n = 8) victims with cord edema only identified at MRI and all of them recovered completely. In ASIA D and E categories, there were 11.1% (n = 10) and 4.4% (n = 4) victims respectively who had cord edema only identified at MRI and all achieved complete recovery.

The post-treatment neurological classification of the patients upon release from hospital as shown in Table 6 revealed a significant improvement of neurological deficit ($p < 0.05$) which closely followed a pattern of not finding intramedullary hemorrhage at MRI.

DISCUSSION

Spinal cord injuries are dreaded everywhere in the world because of severe degree of neurological impairment they leave their survivors with. The injuries are a major cause of death and disability, affecting mostly males [4]. Because of its serious implications, spinal cord injury is given the best medical attention obtainable wherever it occurs. In the work up to treatment, MRI is an integral part of the investigative management and plays a very crucial role.

Our results showed that the injury affects the active workforce of the society more than any segment of the population. Persons aged 45 years and under are at greatest risk. Males are affected more just as the cervical segment of the spinal cord was the most affected segment followed by the lumbar segment. Our results also showed that the commonest etiological factor is road traffic accident. All these findings regarding characteristics of the victims, involved spinal cord segment and etiological factor are in tandem with reports of previous studies [1-3]. Road traffic accidents as the major etiological factor were not surprising. The dominant age groups affected by this injury are very active and move around a lot using presumably motor vehicles. A recent study reported a high incidence of RTAs involving motor vehicles and motor cycles [9]. The cervical and lumbar segments of the spine by their greater freedom of movement are more likely to be injured in rapid deceleration accidents as seen in most road crashes. These injuries to the spine often affect the spinal cord. A study had previously reported RTA as one of the predictors for neurological deficit and types of spinal fractures [3].

One of the goals of clinical evaluation of spinal cord injury patients on initial presentation at the hospital is to determine the degree of neurological deficit. The method used in assessing the severity of loss of sensory and motor functions in this study is the method proposed by the American Spinal Injury Association (ASIA) [8]. Based on decreasing degree of loss of functions, neurological deficits are classified according to the ASIA method as ASIA A, B, C, D and E [8].Before the ASIA classification method, motor and sensory functions were scored according to the Frankel classification [10]. Neurological recovery can therefore be assessed according Frankel classification [10] and the method has predictive value in spinal cord injuries [11]. Our results revealed that on presentation at the hospital, majority of the patients has severe neurological deficits (ASIA classes A and B) while the rest has less severe neurological deficits (ASIA classes C, D and E). This finding is in tandem with the report of a previous study in the locality [2] and these findings highlight the serious nature of most spinal cord injuries in the locality. According to the ASIA classification scale for neurological impairment [8], ASIA A is characterized by complete loss of motor and sensory function in the sacral segments (S4-S5). For ASIA B, sensory but not motor function is preserved below the neurological level and includes the sacral segments (S4-S5) and ASIA C, motor function is preserved below the neurological level and more than half of the key muscles below the neurological level have a muscle grade of less than 3. For ASIA D, motor function is preserved below the neurological level and at least half of the key muscles below the neurological level have a muscle grade of 3 or more and ASIA E is characterized by normal motor and sensory function [8].

The ASIA neurological impairment scale is known to have a direct correlation with MRI signal patterns and hence MRI signal patterns are used for prognostication of acute spinal cord injuries. The sagittal T2-weighted images have been reported to have the highest correlation with patient prognosis [12-14]. T2-weighted sequences can identify and measure the extent of both edema and hemorrhage within the spinal cord. Edema is identified on T2 MRI sequence as hyper intensity of signal within the cord while hemorrhage is identified as hypo intensity, with hemorrhage almost always concurrent with edema [15]. On MRI hemorrhage is always surrounded hyper intensity normally associated with edema [15]. Magnetic resonance image is regarded as the gold standard for imaging neurological tissues including spinal cord [5, 14] but the main reasons why MRI is not frequently used in trauma are the logistics of patient transport and its limited availability in the communities and multitude of MRI sequences to select from [15]. Adequate sequence selection for diagnosis and prognostication can simplify imaging while limiting cost [5].

Our results showed that the more severe neurological impairment (ASIA A and B) comprise hemorrhagic lesions or a combination of hemorrhage and edema. This is in agreement with previous reports that hemorrhage, higher rostro-caudal edema, lesion length, greater degree of cord compression and canal compromise and severity of soft tissue injuries were all associated with poor neurological outcomes [16-20]. The lesion associated with ASIA C, D and E classes on MR imaging was only edema. The recovery pattern revealed that patients with a hemorrhagic lesion and a combination of hemorrhage and edema recovered only limitedly in a few cases while patients with only edema at MRI recovered completely. Thus, there was overall significant improvement of neurological impairment at the end of treatment, especially with the less severe cases.

This study was retrospective and carried with it all the shortcomings of relying on second hand information collected from hospital records. We did not follow the patients prospectively from the time of presentation to the time of discharge and it is possible we may have missed out some vital information. All the patients whose records seem in complete or incomprehensible were excluded from the study and this accounted for the small sample size. This severely limited sample may have compromised precision.

This study has revealed the pattern of spinal cord injury lesions at MRI in the locality. The dominant lesions were hemorrhage and a combination of hemorrhage and edema. This lesion pattern showed direct relationship with ASIA classification scale for neurological impairment and thus was useful for prognostication of the injuries. We therefore, recommend routine use of MR imaging in all cases of traumatic spinal injuries.

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