Characterization of normal lumbar spine in Sudanese population using magnetic resonance images

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Abstract

Introduction: Various medical imaging technique used in radiology to investigate the anatomy and physiology of the body in both health and disease. The main principle of magnetic resonance images (MRI) use strong magnetic field and radio waves to form an image for a certain area in the human body. The technique widely used in the hospital for medical diagnosis. In clinical practice, the MRI is employed for the assessment of lower back in the human body. Knowledge of lumbar the spine character is important for the clinical assessment of spine diseases. **Materials and Methods:** This study consisted Fifty nine consecutive patients gender both males and females Ages between 18-45 years adult with no known history of lumbar spine diseases underwent lumbar spine MRI sagittal T1, T2-weighted images. MRI machine 1.5 Tesla was used the selected sequences were Scout: axial sagittal, and coronal. **Objective:** The aims of this study were to establish a normal range of values for lumbar spine length (high) and classify the signal intensities by use of MRI for normal Sudanese adult with no known history of lumbar spine diseases. **Result:** Of this study revealed Correlation between measurement of the lumbar spine and body indices. The data were expressed as means ± standard deviation (S.D). Lumbar spine length (high) and signal intensity were analyzed as combine group (male + female) as well as the total sample. The data statistical analyses were performed using excel software programmed and statistical analyses were performed using the independent sample *t*-test, simple correlation (SPSS software version 20 USA) statistical significance was assumed at $P < 0.05$. **Conclusion:** The lumbar spine length (high) for Sudanese adult were found to be in the ranges of (13.8-23.4) cm with mean = 16.9 ± 1.7 S.D. the signal intensities for lumbar spine in MRI fast spin echo image (FSE) were found to be in the ranges (61-163) pixel value (45-110) pixel value for vertebrae and inter vertebral disc respectively.

Key words: Lumbar spine signal intensity, magnetic resonance images, measurement lumbar spine magnetic resonance images, normal lumbar spine length in magnetic resonance images, SI fast spin echo in lumbar spine

INTRODUCTION

The vertebral column is situated in a median line, as the posterior part of the trunk; its average length in the female column is about 61 cm in length. The male is about 71 cm of this length the cervical part measures 12.5 cm, the thoracic about 28 cm, the lumber 18 cm, and the sacrum and coccyx 12.5 cm.[1]

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Access this article online

Quick Response Code:

Website: www.sudanmedicalmonitor.org

DOI: 10.4103/1858-5000.178508

How to cite this article: Hassib MA, Garelnabi MM, Haraz AB. Characterization of normal lumbar spine in Sudanese population using magnetic resonance images. Sudan Med Monit 2016;11:19-22.

The diagnosis of lumbar spine involves clinical investigation and imaging of the spine a variety of imaging modalities such as X-ray, computed tomography (CT), and magnetic resonance images (MRI) are used for this purpose. Additional imaging approaches include myelography and discography, combined with either X-ray or CT.[2]

MRI is a good modality for imaging the spine and the most sensitive method for evaluating the lumbar spine. It provides high soft tissue contrast, allowing good visualization of the intervertebral disc as well as the surrounding nerves, ligaments, and muscles. In addition, it is noninvasive, does not use ionizing radiation, and is capable of multiplanar imaging.[3]

The standard MRI protocol for lumbar spine consist of sagittal T1- and T2-weighted images, supplemented by axial T1- or T2-weighted images at selected levels.[4] T1-weighted images show low signal intensity from the cerebrospinal fluid (CSF), and cortical bone and high signal intensity from the bone marrow. The T2-weighted images show high signal intensity from structures with high water content such as the (CSF) and disc's nucleus. In sagittal T2-weighted images, a normal intervertebral disc appears as a bright ellipse the nucleus surrounded by a dark ring the annulus while the end plates and ligaments also appear dark.[5]

From the length of the lumbar part of spine (LLPS), LLPS in centimeters, the latter being measured from the upper edge of the first lumbar vertebral body, to the lower edge, along the anterior surface of the spine. LLPS were 19.9 ± 1.19 cm in males and 18.6 ± 0.84 cm in females (mean ± standard deviation [S.D]).[6,7]

Relative signal intensity maybe a more sensitive measure of intervertebral disc degeneration. Also, signal intensity was lower in the middle-aged men than in the young men, indicating age-related disc degeneration. Despite the general positive association between disc narrowing and decreased relative signal intensity, disc narrowing may be have unexpectedly in relation to signal intensity and age.[8,9]

MATERIALS AND METHODS

This study consisted of 59 consecutive patients (males = 31, female = 28) underwent lumbar spine MRI sagittal T1-weighted, T2-weighted images of indication other than lumbar spine disease the sample includes both males and females ages between 18 and 45 years adult with no known history of lumbar spine diseases. Detailed demographic information of the population including age, gender, weight, and high, body mass index (BMI) will be record.

MRI machine 1.5 Tesla was used at Doctors hospital, the selected sequences were Scout: Axial sagittal, and coronal. Sequence 1 and 2 were coronal and axial T2-weighted: TSE, TR = 3000-4000, TE = 90–140, respiratory triggering TR = 1900-2300, TE = 100, Flip angle 90°(degree) STIR: TR = 2200, TE = 60, TI = 100 HASTE, breath hold; TR = 11.9, TE = 95, Slice thickness 4–6 mm. Slice gap: (0.8-1.2 mm), phase encoding gradient: LR, FOV: 380–400 mm, sequence 3 was axial T1-weighted, GRE (FFE) [Figure 1].

The researcher's measures length of vertebrae and intervertebral disc in MRI by use computer program (RadiAnt DICOM Viewer). Interactive data language (IDL) Version 6.1 use to extract pixel value from same MRI (Signal intensity). In the signal intensity analysis open the T1-fast spin echo (FSE) MRI in IDL program and extract pixel value from vertebrae and intervertebral disc. Finally Microsoft Office Excel Worksheet was used to predict the high (length) of lumbar spine in (cm). *Length of lumbar spine* from MR image = [∑ length of five lumbar vertebrae + ∑ length of five intervertebral disc].

RESULT AND DISCUSSION

This study adept analytic cross-sectional design focuses on measure the length of lumbar spine and analysis the signal intensity of vertebrae, and intervertebral disc in MRI this study science in Khartoum state Doctors Clinic hospital period from September 2014 to February 2015. The demographic information for the total sample was recorded as shown in Table 1.

The data are collected for 59 patients showed the measurement and signal intensity of lumbar spine correlated with patient's age, weight, length, and BMI.

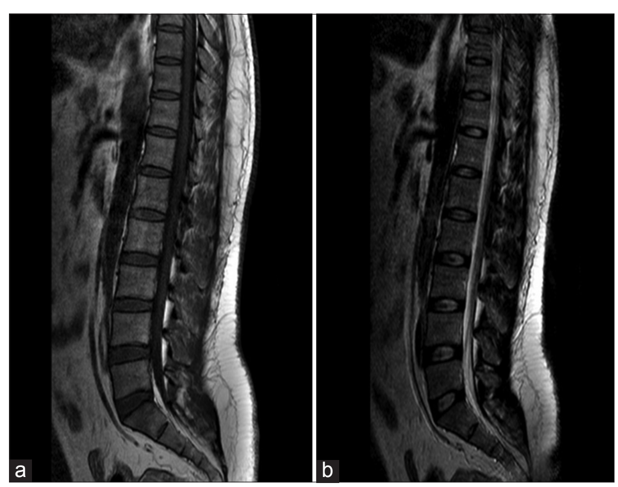

Figure 1: (a) Lumbar spine magnetic resonance images T1-fast spine echo image, (b) lumbar spine magnetic resonance images T2-fast spine echo image

The data statistical analyses were performed using the independent sample *t*-test and linear regression for variables (SPSS software version 20, IBM® SPSS® Statistics, USA). Statistical significance was assumed at $P \leq 0.05$ where the result as shown in the following Tables 2-4.

The mean and standard deviation of length of lumbar spine (which measured individually) was 16.93 ± 1.68 cm, these result compared with Dimeglio and Bonnel,[10] were found the measurement of lumbar spine 16 cm which was similar to our study.

Also study show statistically significant, between lumbar spine length and patient height [Figure 2]. These results compare with Yanase *et al*.[11] the findings suggest that the increased length of the lumbar spine with patient height.[12]

In this study explained measurement of the length of individual lumbar vertebrae and intervertebral disc in all cases. As shown in Table 5.

Also, the pixel values for lumbar vertebrae and intervertebral disc (signal intensity analysis) in T1-FSE MRI ranged as shown in Table 6.

Distinguish the pixel value for vertebrae and intervertebral disc as in Table 6, which can be obtain intensity profiles based on the images analysis of MRI lumbar spine images that exploits some basic anatomical properties of the lumbar spine. This is consistent with that reported by Chwialkowski *et al*. 1989.[13,14,15,12]

The compression between the pixel values for vertebrae with intervertebral disc as in Table 6 leading to the values of intervertebral always be less than the values of vertebrae due to the formation of MRI where the signal intensity depends on the presence of mobile hydrogen atom, (proton) that is, the vertebrae values is high (hyperintensity) because the presence of the bone marrow which is rich by the protons. As well as intervertebral disc values is low (hypointensity) due to it containing fluids and soft nucleus pulposus. As stated in Vande Berg *et al*. 1999.[16,17,18]

Table 1: Statistical descriptive total sample

Statistics

		gender	age (yrs)	wieght (kg)	hight (cm)	BMI
N	Valid	59	59	59	59	59
	Missing	0	0	0	0	0
Std. Deviation			9.323	9.899	6.570	3.521219
Minimum			18	67	167	19.810
Maximum			50	105	189	35.080
Sum			1903	4781	10549	1500.120

Table 2: Linear regression (stepwise method) entered variables

Variables Entered/Removed^a

Model	Variables Entered	Variables Removed	Method
1	high	.	Stepwise (Criteria: Probability-of-F-to-enter <= .050, Probability-of-F-to-remove >= .100).

a. Dependent lumber vertebrae high

Table 3: Linear regression (stepwise method) excluded variables

Excluded Variables^a

Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics Tolerance
1	age	-.036^b	-.282	.779	-.038	.999
	weight	.168^b	1.324	.191	.174	.985
	BMI	.174^b	1.239	.221	.163	.807

a. Dependent lumber vertebrae high

b. Predictors in the Model: (Constant),high

Table 4: Compare means independent sample (*t*-test)

Coefficients^a

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	3.566	5.806		.614	.542
	high	.075	.032	.292	2.305	.025

a. Dependent lumber vertebrae high

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	14.004	1	14.004	5.312	.025^b
	Residual	150.275	57	2.636		
	Total	164.279	58			

a. Dependent Variable: lumber vertebrae high

b. Predictors: (Constant), high

CONCLUSION

- The lumbar spine length (high) is clinically relevant and use frequently as the basis for making a clinical

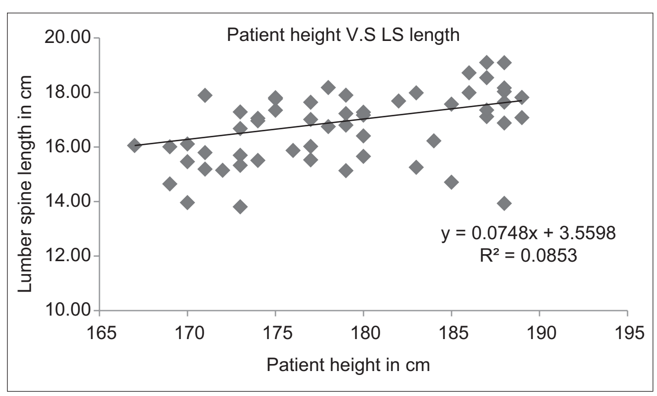

Figure 2: Scatter plot show relationship between patient height and lumbar spine length

Table 5: Average of individual lumbar vertebrae and intervertebral disc in all cases

Structure	Length (cm)	Structure	Length (cm)
1st lumbar vertebrae	2.49	1st intervertebral disc	0.61
2nd lumbar vertebrae	2.54	2nd intervertebral disc	0.76
3rd lumbar vertebrae	2.54	3rd intervertebral disc	0.87
4th lumbar vertebrae	2.49	4th intervertebral disc	0.97
5th lumbar vertebrae	2.41	5th intervertebral disc	0.90

Table 6: Signal intensity analysis for lumbar vertebrae and intervertebral disc

Structure	Pixel value range	Mean±SD
1st lumbar vertebrae	79-140	97.22±14.23
2nd lumbar vertebrae	74-152	98.23±15.81
3rd lumbar vertebrae	73-150	97.23±14.29
4th lumbar vertebrae	74-163	96.23±16.11
5th lumbar vertebrae	61-153	92.92±15.78
L_1-L_2 intervertebral disc	53-110	73.03±9.69
L_2-L_3 intervertebral disc	54-86	70.63±6.18
L_3-L_4 intervertebral disc	51-95	69.25±7.07
L_4-L_5 intervertebral disc	49-82	68.03±6.86
L_5-S_1 intervertebral disc	45-95	66.18±8.37

SD: Standard deviation

decision. Serial measurements also can provide information regarding disease progression or stability

- Aims of this study were to establish normal lumbar spine length (high) and values of signal intensity of Sudanese adults using MRI as well as to determine the relations between lumbar spine measurement and Sudanese body indices
- Correlation between measurement of the lumbar spine and body Indies were calculated. The lumbar spine length (high) of Sudanese adults were found to be in the ranges of (13.8–23.4) with mean = 16.9 ± 1.7 S.D
- Relation between body height and lumbar spine length which can be represented by an equation and used as an easy reference in clinical practice: Lumber spine length (cm) = (0.074 × pt high + 3.359)
- The signal intensity profiles can provide useful information about the microstructures of the structures the interest can speed the process of diagnosis. There for the main objective of this study was to use signal intensity technique in order to identify the pathological lumbar spine from the normal one.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

REFERENCES

1. Drake RL, Vogl AW, Adam WM. Gray's Anatomy for Students. 2nd ed. ASIN: B004LGYXQQ. London: Churchill Livingstone; 2009.
2. van Goethem JW, Baert AL, van den Hauwe L, Parize PM. Diagnostic Imaging of the Spine and Spinal Cord; 2003.
3. Bogduk N, Livingston C, Clinical and radiographic Anatomy of the lumber spine Ontario, Canada; 2012.
4. Westbrook C. Handbook of MRI Technique. 3rd ed. Wiley-Blackwell; 2013. p. 400.
5. Reif E, Moeller T. MRI Parameters and Positioning, Thieme; 2014 Printed in Germany by Druckhaus Götz, Ludwigsburg; 2014.
6. Terazawa K, Akabane H, Gotouda H, Mizukami K, Nagao M, Takatori T. Estimating stature from the length of the lumbar part of the spine in Japanese. Med Sci Law 1990;30:354-7.
7. Thalgott JS, Albert TJ, Vaccaro AR, Aprill CN, Giuffre JM, Drake JS, *et al.* A new classification system for degenerative disc disease of the lumbar spine based on magnetic resonance imaging, provocative discography, plain radiographs and anatomic considerations. Spine 2004;4:167S-72S.
8. Kjaer P, Korsholm L, Bendix T, Sorensen JS, Leboeuf-Yde C. Modic changes and their associations with clinical findings. Eur Spine J 2006;15:1312-9.
9. Luoma K, Vehmas T, Riihimäki H, Raininko R. Disc height and signal intensity of the nucleus pulposus on magnetic resonance imaging as indicators of lumbar disc degeneration. Vol. 14. ©Springer International Publishing AG, Part of Springer Science: Lippincott Williams & Wilkins; 2002. p. 177-200.
10. Dimeglio A, Bonnel F. The growing spine (The Spinal Column in Growth). Paris: Springer; 1990.
11. Yanase M, Matsuyama Y, Hirose K, Takagi H, Yamada M, Iwata H, *et al.* Measurement of the cervical spinal cord volume on MRI. J Spinal Disord Tech 2006;19:125-9.
12. Modic MT, Masaryk TJ, Ross JS, Carter JR. Imaging of degenerative disk disease. Radiology 1988;168:177-86.
13. Adams MA, Roughley PJ. What is intervertebral disc degeneration, and what causes it? Spine (Phila Pa 1976) 2006;31:2151-61.
14. Bartlett RJ, Hill CR, Gardiner E. A comparison of T2 and gadolinium enhanced MRI with CT myelography in cervical radiculopathy. Br J Radiol 1998;71:11-9.
15. Chwialkowski MP, Shile PE, Peshock RM, Pfeifer D, Parkey RW. Automated detection and evaluation of lumbar discs in MR images. 27th Annual International Conference; 1989. p. 2527-30.
16. Bazin PL, Pham DL. Statistical and topological atlas based brain image segmentation. Med Image Comput Comput Assist Interv 2007;10(Pt 1):94-101.
17. Toyone T, Takahashi K, Kitahara H, Yamagata M, Murakami M, Moriya H. Vertebral bone-marrow changes in degenerative lumbar disc disease. An MRI study of 74 patients with low back pain. J Bone Joint Surg Br 1994;76:757-64.
18. Vande Berg BC, Malghem J, Lecouvet FE, Maldague B. Magnetic resonance imaging of normal bone marrow. Eur Radiol 1998;8:1327-34.