ORIGINAL ARTICLE

Diagnostic Accuracy of Magnetic Resonance Imaging in Detecting Spinal Tumor, Taking Histopathology as a Gold Standard

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ABSTRACT

Background: Spinal tumors can be easily classified using magnetic resonance imaging (MRI), which is crucial for tumor characterization.

Objective: To determine the diagnostic accuracy of MRI in detecting spinal tumors, taking histopathology as a gold standard.

Methods: This cross-sectional study was conducted at the Department of Radiology, Liaquat National Hospital & Medical College, Karachi, from May 2024 to November 2024. A total of 150 patients were included. MRI images were analyzed for location, shape, extent, component characteristics, signal intensities across different MRI sequences, and lesion enhancement patterns. A biopsy was done after an MRI. After receiving histopathological and radiological results, a diagnosis was made. Data were analyzed using SPSS version 27.

Results: Out of 150, 53.3% were males, with a mean age of 40.40±12.215 years. Mean duration of symptoms was 7.93±8.50 months. On MRI, Ependymoma, Astrocytoma, Hemangioblastoma, Meningioma, Schwannoma, and Extradural were 15.3%, 7.3%, 2.7%, 18%, 22.7%, and 0.9%, respectively. However, in histopathology, these were 16%, 8.7%, 2.7%, 18.7%, 20%, and 8.7%, respectively. Sensitivity, Specificity, PPV, NPV, and accuracy were 95.5%, 85.0%, 94.6%, 87.2%, and 92.7%, respectively.

Conclusion: MRI demonstrated high diagnostic accuracy for spinal tumors, with histopathology as the gold standard.

Keywords: *Diagnostic accuracy, MRI, spinal tumor, histopathology, diabetes mellitus.*

INTRODUCTION

Spinal tumours can also cause significant morbidity and mortality. A spinal tumour is an unusual growth that develops inside or near the spinal cord and spinal column. Spinal cord, nerve root, meninges, sympathetic chain, intraspinal artery, or vertebrae might be the site of an intratumoral tumour. It could cause minor discomfort or significant illness, depending on whether it's benign or malignant. Tumours within the spinal cord are not very prevalent [1-3].

Primary tumours of the spinal cord are much less common than those of the brain [4]. There are three distinct types of these tumours: intradural, extra-medullary, and intradural intramedullary [5]. It is essential to have a strong suspicion to pursue a spinal tumour diagnosis because these tumours might cause nonspecific symptoms [6, 7].

The diagnosis of spinal tumours relies heavily on radiological imaging techniques. Quick and accurate treatment can be started for patients using these scans [8]. For the majority of spinal cord injuries, the first imaging modalities utilised for diagnosis are computed tomography (CT) and conventional radiographs. Patients with spinal tumours are benefiting greatly from magnetic resonance imaging (MRI). In particular, when assessing ligaments and other soft-tissue structures, the disc, the spinal cord, and hidden osseous injuries, magnetic resonance imaging (MRI) is the gold standard [9, 10].

The importance of non-invasive magnetic resonance imaging in spine evaluations is rapidly growing. Magnetic resonance imaging (MRI) allows multiplanar imaging and provides good contrast for soft tissues [11, 12]. Common MRI sequences used to assess the spine include T1- and T2-weighted spin-echo and gradient-echo imaging. Important for spinal tumour visualisation, it facilitates tumour classification as intradural, intradural extra-medullary, or intramedullary; this information is valuable for tumour characterization [13].

The imaging of all neoplastic tumours is now best accomplished by magnetic resonance imaging (MRI). When it comes to diagnosing and defining soft-tissue components, magnetic resonance imaging (MRI) is second to none [1, 14]. Although they were unable to differentiate between astrocytomas and lymphomas, Asiltürk M. *et al.* found that MRI can aid in diagnosing spinal benign lesions and metastases [4].

To determine whether magnetic resonance imaging (MRI) is beneficial for diagnosing spinal tumours, Saha GC *et al.* studied 51 patients, of whom MRI confirmed 78.4% (40/51) of clinically suspected spinal

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tumours. In contrast, 82.3% (or 42/51) were confirmed by histological examination. With a sensitivity of 92.86%, specificity of 88.89%, positive predictive value of 97.50%, accuracy of 72.73%, and negative predictive value of 92.15% for the diagnosis of spinal tumours, magnetic resonance imaging (MRI) was adequate. When diagnosing spinal tumours, they found that magnetic resonance imaging (MRI) had high sensitivity and specificity. The researchers also recommended using magnetic resonance imaging (MRI) as the first-line test for diagnosing possible spinal tumours [11, 15]. A different study found that, among all patients, the set of diagnoses had a sensitivity of 83.2% (95% CI: 80.6 to 85.7%). When the top 10 tumours were combined, the overall specificity was 91.3% (90.7-92.5%) [16].

Using histology as a reference, a large body of research worldwide shows that magnetic resonance imaging (MRI) is a reliable tool for diagnosing spinal tumours. Nevertheless, current evidence on the most effective applications of MRI for spinal tumours is restricted and poor. Hence, using histopathology as a benchmark, this study aims to determine the diagnostic accuracy of MRI in identifying spinal tumours. To aid early tumour detection, this study will guide doctors to a reliable imaging tool that clearly defines soft-tissue components.

METHODOLOGY

This cross-sectional study was conducted at the Department of Radiology, Liaquat National Hospital & Medical College, Karachi, Pakistan from May 2024 to November 2024. The Hospital Ethics Committee reviewed and endorsed the study protocol, granting formal approval (Ref#: 1012-2024). Patients aged 20 to 65 years of either gender, who underwent MRI and were investigated for histopathology, were included. All patients clinically suspected of having spinal tumors were the targeted population of this study. Patients not willing to undergo MRI or having any surgery before imaging or with a history of spinal injury were excluded. After obtaining signed informed consent, all patients were enrolled.

Sample size was estimated with a spinal tumor prevalence of 82.3% [11] at a 95% confidence interval and a 7% margin of error, yielding 115. However, we rounded this number to around 50 for better results and enrolled 150 patients. The non-probability consecutive sampling approach was employed.

The shape, location, extent, component properties, signal intensities across various MRI sequences, and enhancement patterns of the lesions were all considered in analyzing the MRI images. Extradural, intradural, extra-medullary, and intramedullary compartments were used to categorize the lesions. The Brivo 358-General Electric 1.5 Tesla MRI equipment was used for all of the study's MRI scans. The MRI protocol employed was as follows. T1, T2 (sagittal and axial, coronal), DWI and ADC, STIR (sagittal), and post-contrast T1 (sagittal, coronal, axial) with intravenous gadolinium administration of 0.1 mmol/kg body weight will be utilized. An experienced senior radiologist evaluated all images. Spinal tumor on MRI was labeled as "positive" when the focal or diffuse spinal cord expansion or compression was shown, which produced high signal intensity on proton density and T2-weighted images.

A biopsy was performed after the MRI by the relevant department, and the specimen was sent for histopathology as per hospital protocols. The histopathology reports were received and noted from the histopathological laboratory. After receiving histopathological and radiological results, a diagnosis was made and recorded on a pre-designed proforma. The types of spinal tumors were also noted according to MRI and histopathology findings.

Data were entered and analyzed using SPSS version 27. Frequency and percentages were calculated for categorical variables. Numerical data were summarized as mean ± SD. A 2x2 contingency table was used to calculate the sensitivity, specificity, positive predictive value, negative predictive value, and diagnostic accuracy of MRI, taking histopathology as the gold standard. The chi-square or Fisher's exact test was used to compare MRI and histopathological findings. P-value <0.05 was considered statistically significant.

RESULTS

A total of 150 patients, of either gender, aged 20-65 years, meeting the study's inclusion criteria were included to calculate the diagnostic accuracy of Magnetic resonance imaging (MRI) for the detection of spinal tumors, using histopathological findings as the gold standard. The overall mean age was 40.40±12.215 years. The mean duration of symptoms was 7.93±8.50 months. Among 150 patients, 53.3% were male and 46.7% were female. 74.0% of patients were from urban areas, and 26.0% were from rural areas. 6.7% patients have diabetes mellitus (DM), and 24.3% patients had Hypertension. There was 72.6% of patients found with numbness, 86.6% with backache, 52% with paraplegia, 64% with upper limb weakness, 76.6% with lower limb weakness, and 12% with urinary incontinence (**Table 1**).

On histopathology, of 150 patients, 73.3% were found to have spinal tumors, whereas on MRI, 74% were found to have positive findings. As far as conclusions regarding spinal tumor characterization on MRI and histopathology are concerned, it was observed that, on MRI, Ependymoma, Astrocytoma, Hemangioblastoma, Meningioma, Schwannoma, and Extradural accounted for 15.3%, 7.3%, 2.7%, 18%, 22.7%, and 0.9%, respectively. However, in histopathology, these findings were 16%, 8.7%, 2.7%, 18.7%, 20%, and 8.7%, respectively. The detailed frequency distribution of tumor characterization on MRI and histopathology is presented in Table **2**.

Table 1: Frequency distribution of sociodemographic variables.

Variables	Frequency (%)
Age groups	
≥40 years	76(50.7)
>40 years	74(49.3)
Gender	
Male	80(53.3)
Female	70(46.7)
Residence	
Urban	111(74)
Rural	39(26)
Comorbidity	
Hypertension	36(24).
Diabetes	10(6.7)
Presenting complaints	
Numbness	109(72.7)
Backache	130(86.7)
Paraplegia	78(52)
Upper limb weakness	96(64)
Lower limb weakness	115(76.7)
Urinary continence	18(12)

Table 2: Frequency distribution of diagnoses of types of spinal tumors according to MRI and histopathology.

Diagnosis	MRI Findings n(%)	Histopathology Findings n(%)
Ependymoma	23(15.3)	24(16)
Astrocytoma	11(7.3)	13(8.7)
Hemangioblastoma	4(2.7)	4(2.7)
Meningioma	27(18)	28(18.7)
Schwannoma	34(22.7)	30(20)
Extradural	13(8.7)	13(8.7)

The results showed that by MRI scan, 105 patients were true positives and 34 patients were true negatives. Sensitivity, Specificity, PPV, NPV, and accuracy were 95.5%, 85.0%, 94.6%, 87.2%, and 92.7%, respectively, as presented in Table **3**.

Table 3: Diagnostic accuracy of MRI with histopathology as gold standard in the diagnosis of spinal tumors.

Spinal Tumor by MRI	Spinal Tumor by Histopathology			p-value
	Positive n(%)	Negative n(%)	Total n(%)	
Positive	105(95)	6(5)	111(74)	***<0.001**
Negative	5(12.8)	34(87.2)	**39(26)**	
Total	**110(73.3)**	**40(26.7)**	**150(100)**	
Sensitivity (%)	**Specificity (%)**	**PPV (%)**	**NPV (%)**	**Accuracy (%)**
95.5	**85.0**	**94.6**	**87.2**	**92.7**

*Significant at p<0.05, PPV: Positive predictive value, NPV: Negative predictive value

DISCUSSION

Fifteen percent of all neoplasms of the central nervous system are spinal cord tumors. To aid in tumor type diagnosis, spinal cord cancers can be classified by anatomical site [15]. Back pain, increasing paraparesis, sensory loss, and sphincter dysfunction are some of the symptoms associated with spinal tumors [3]. Using histology as the gold standard, the current study focuses on the diagnostic accuracy of MRI in the evaluation of spinal malignancies (**Figs. 1 and 2**).

To provide the proper treatment, a thorough and accurate diagnosis of neurologic symptoms is required [11, 17]. There were 46.7% females and 53.3% males in our study. A study [15] found that adults and men had higher rates of spinal neoplasms. In a similar vein, Panda's study [3] reported that 57.3% were men and 42.7% were women. These are comparable to our research as well.

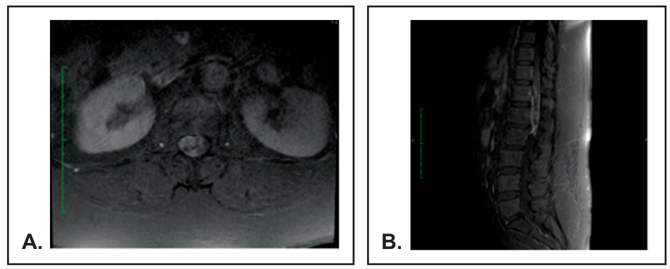

Fig. (1A&1B): MRI axial and sagittal Images of patient showing and intradural extramedullary abnormal signal intensity lesion is lower spinal cord likely representing an ependymoma.

In a previous study [15], the mean age was 39 years. Among them 7.8% were in the age group of ≤20 years, 13.7% were in the age group of 21 to 30 years, 27.5% were in the age group of 31 to 40 years, 35.3% were in the age group 41-50 years, 9.8% were in the age group of 51 to 60 years and rest 5.9% were in the age group of >60 years. Among them, 5.6% were in the pediatric age group, and 94.4% were adults. The majority of spinal tumors are seen in elderly patients, with the most common age group being 41 to 50 years. This observation is similar to a study conducted by Panda [3], which also found the most common affected age group to be 41 to 50 yrs. In our study, the mean age was 40.40±12.215 years; among them, 50.67% were in the age group ≤40 years, and 49.33% were in the age group> 40 years.

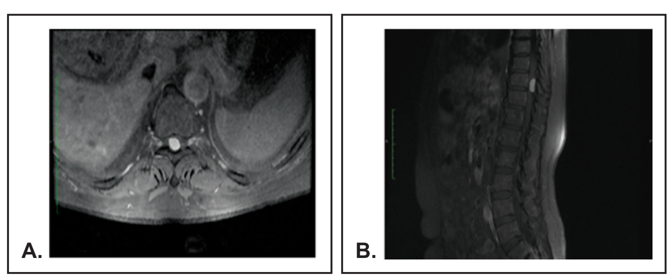

Fig. (2A&2B): MRI spine axial and sagittal images showing an intradural extramedullary enhancing lesion in the spinal cord at the level of D11 vertebra, representing an ependymoma.

40 of the 51 patients in a prior study [11] had a spinal tumor diagnosis, while 11 did not have an MRI diagnosis.

Of the forty spinal tumors identified, schwannoma accounted for 23.5%, neurofibroma for 3.9%, meningioma for 11 (21.6%), ependymoma for 7 (13.7%), astrocytoma for 5 (9.8%), metastasis for 2 (3.9%), and osteoblastoma for 1 (2.0%). Of all the cases, 40 had an MRI diagnosis of a spinal tumor, and 39 of those instances had histological confirmation. In our study, MRI revealed that Ependymoma, Astrocytoma, Hemangioblastoma, Meningioma, Schwannoma, and Extradural tumours were 15.3%, 7.3%, 2.7%, 18%, 22.7%, and 0.9%, respectively. However, in histopathology, these findings were 16%, 8.7%, 2.7%, 18.7%, 20%, and 8.7%, respectively.

The sensitivity, specificity, PPV, NPV, and accuracy of the MRI was 92.86%, 88.89%, 97.50%, 72.73%, and 92.15%, respectively [11]. According to our study, 34 patients had genuine negative diagnoses and 105 had true-positive diagnoses based on MRI scans. The corresponding values for sensitivity, specificity, PPV, NPV, and accuracy were 95.5%, 85.0%, 94.6%, 87.2%, and 92.7%.

The total discordance rate was almost 7.3% after six false-positive and five false-negative cases were found. This rate is similar to the conflicting results published in earlier research [11, 18]. These differences are mainly due to overlapping MRI features across various tumour types, an intrinsic MRI limitation that cannot be entirely overcome.

Another study [3] compared MRI findings with histology, which was considered the gold standard. Twenty-five of the 140 patients were true positives, 112 were true negatives, two were false positives, and one was a false negative. MRI's overall sensitivity was 96.2%, its specificity was 98.2%, and its diagnostic accuracy was 97.9%. Its positive predictive value was 92.6%, and its negative predictive value was 99.1%. According to research by Pourissa *et al.* [19], MRI has a sensitivity of 94% for diagnosing spinal malignancies. This demonstrates that MRI is unquestionably the appropriate modality for the detection of spinal tumors, with diagnostic accuracy.

Epidural metastases, meningioma, hemangioblastoma, astrocytoma, lipoma, hemangioma, oligodendroglioma, and epidermoid cyst were the most common tumors, accounting for 23% of cases each [15]. Schwannomas are the most prevalent tumor, followed by meningiomas, ependymomas, *etc.*, according to Chung *et al.* [2] and Panda [3]. According to Parizel *et al.* [20], ependymomas are the most prevalent tumors in adults. Intradural extra medullary tumors were more common than intramedullary tumors, according to a study by Ravi *et al.* [1].

Results from recently completed research on primary spinal tumors have demonstrated that many tumors can be identified by their characteristic imaging patterns. A large study based on 1321 patients reported that common histological type was schawnnoma (38.68%) followed by spinal meningioma (13.93%) and ependymoma (7.65%) [21]. Approximately 1/4 of the tumors evaluated in this study were less common and comprised various types of spinal neoplasms. Gupta *et al.* found that the most common location was intradural extramedullary (37.93%) [22]. Among the remaining tumor types identified in this study, chordomas, hemangiomas, lymphomas, and lipomas were each diagnosed infrequently. Taken as a whole, the data suggest that meningiomas are the second-most frequent spinal tumor, after nerve sheath neoplasms.

This study has notable limitations, including being a single-center study, a relatively small sample size, and the absence of an assessment of observer variability.

CONCLUSION

Using histology as the gold standard, our study found that MRI had high sensitivity (95.5%), specificity (85.0%), and diagnostic accuracy (92.6%) in diagnosing spinal tumors. In summary, MRI is a very precise, non-invasive, secure, and practical imaging technique for the assessment of spinal malignancies.

Because MRI makes it simple to classify tumors as intradural extra-medullary or intramedullary, which is very helpful in tumor characterization and plays a crucial role in early detection, planning management, and estimating patient prognosis, it should be the first procedure used to evaluate suspected spine tumors.

ETHICS APPROVAL

This study received an exemption from the Institutional Review Board under approval number: 1012-2024. All procedures involving human participants were conducted in accordance with the ethical standards of the institutional and/or national research committee and the Declaration of Helsinki.

CONSENT FOR PUBLICATION

Informed consent was obtained from the participants.

AVAILABILITY OF DATA

The data is available from the corresponding author upon reasonable request.

FUNDING

None.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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Declared none.

AUTHORS' CONTRIBUTION

AA: contributed to the study conception and design, data acquisition, analysis, interpretation, and manuscript writing. RA: was actively involved in manuscript drafting, critical revision for important intellectual content, and coordination of the overall project. AS: contributed significantly to data acquisition, patient follow-up, clinical documentation, data interpretation, and provided substantial input during manuscript revision. SA: provided overall guidance, supervised the research process, and approved the final version of the manuscript. UP: participated in manuscript editing. DF: ensured alignment of the study findings with current literature.

REFERENCES

1. Ravi N, Manjappa BH, Nagaraj BR, Naveen KG, Lakshmeesha MT, Ramesh V, *et al.* MRI Evaluation of different spectrum of spinal tumors: SSRG Internation J Med Sci 2014; 1(2): 14-30.
   DOI: https://doi.org/10.14445/23939117/IJMS-V1I2P102

2. Chung JY, Lee JJ, Kim HJ, Seo HY. Characterization of magnetic resonance images for spinal cord tumors. Asian Spine J 2008; 2(1): 15-21.
   DOI: https://doi.org/10.4184/asj.2008.2.1.15

3. Panda SK. MRI Evaluation of intramural tumors of spine in adult and pediatric population- a study at tertiary care centre. J Dental Med Sci 2018; 17(1): 33-8.

4. Asiltürk M, Abdallah A, Sofuoglu EÖ. Radiologic–histopathologic correlation of adult spinal tumors: A retrospective study. Asian J Neurosurg 2020; 15(2): 354-62.
   DOI: https://doi.org/10.4103/ajns.AJNS_366_19

5. Chamberlain MC, Tredway TL. Adult primary intradural spinal cord tumors: A review. Current Neurol Neurosci Report 2011; 11(3): 320-8.
   DOI: https://doi.org/10.1007/s11910-011-0190-2

6. Chikani MC, Okwunodulu O, Mesi M, Mezue WC, Ohaegbulam SC, Ndubuisi CC. Surgically treated primary spinal cord neoplasms in Southeastern Nigeria. J Neurosci Rural Pract 2018; 9: 137.
   DOI: https://doi.org/10.4103/jnrp.jnrp_391_17

7. Emel E, Abdallah A, Özer AF. Taking history and patient assessment in spinal surgery. Princip Spine Surg 2017; 1: 99-108.

8. Rajasekaran S, Vaccaro AR, Kanna RM, Schroeder GD, Oner FC, Vialle L, *et al.* The value of CT and MRI in the classification and surgical decision-making among spine surgeons in thoracolumbar spinal injuries. Europ Spine J. 2017; 26(5): 1463-9.
   DOI: https://doi.org/10.1007/s00586-016-4623-0

9. Saifuddin A. MRI of acute spinal trauma. Skeletal Radiol 2001; 30: 237-46.
   DOI: https://doi.org/10.1007/s002560100354

10. Kumar Y, Hayashi D. Role of magnetic resonance imaging in acute spinal trauma: A pictorial review. BMC Musculoskelet Disorder 2016; 17(1): 1-10.
    DOI: https://doi.org/10.1186/s12891-016-1169-6

11. Saha GC, Biswas PK, Rahman MM, Hossain MS, Hossain MZ, Kabir AH, *et al.* Magnetic resonance imaging evaluation of spinal tumors and its comparison with histopathological findings. J Dhaka Med Col 2017; 26(2): 162-6.
    DOI: https://doi.org/10.3329/jdmc.v26i2.38837

12. Struffert T, Grunwald I, Roth C, Reith W. Spinaleintradurale Tumore. Der Radiologe 2004; 44(12): 1211-28.
    DOI: https://doi.org/10.1007/s00117-004-1135-4

13. Berns DH, Blaser SI, Modic MT. Magnetic resonance imaging of the spine. Clinic Orthop Relat Res 1989; 244: 78-100.

14. Emel E, Abdallah A, Sofuoglu OE, Ofluoglu AE, Gunes M, Guler B, *et al.* Long-term surgical outcomes of spinal schwannomas: Retrospective analysis of 49 consecutive cases. Turk Neurosurg 2017; 27: 217-25.
    DOI: https://doi.org/10.5137/1019-5149.JTN.15678-15.1

15. Dasarju VK, Sree S, Kikkeri MS, Shireesha B, Pallavi N, Kumar CH. Magnetic resonance imaging in spinal tumors. Int J Contempor Med Surg Radiol 2020; 5(1): 232-36
    DOI: http://dx.doi.org/10.21276/ijcmsr.2020.5.1.50

16. Kajikawa K, Nagoshi N, Tsuji O, Suzuki S, Ozaki M, Takahashi Y, *et al.* Clinical and imaging characteristics of non-neoplastic spinal lesions: A comparative study with intramedullary tumors. Diagnostics 2022; 12: 2969.
    DOI: https://doi.org/10.3390/diagnostics12122969

17. Bilsky MH, Lis E, Raizer J, Lee H, Boland P. The diagnosis and treatment of metastatic spinal tumor. Oncologist 1999; 4(6): 459-69.

18. Saeed S, Ashraf A, Hayat AM, Basharat R, Khan MI, Nizam M. Diagnostic accuracy of MRI in the detection of intradural intramedullary spinal tumors. Br J Healthcar Med Res 2022; 9(5): 36-43.
    DOI: www.doi.org/10.52768/2766-7820/2088

19. Pourissa M, Refahi S, Dehghan MH. Report and review of spinal cord tumors. Res J Biol Sci 2007; 2: 654-7
    DOI: https://doi.org/10.4184/asj.2008.2.1.15

20. Parizel PM, Balériaux D, Rodesch G, Segebarth C, Lalmand B, Christophe C, *et al.* Gd-DTPA– enhanced MR imaging of spinal tumors. AJR Am J Roentgenol 1989; 152(1): 1087-96
    DOI: https://doi.org/10.2214/ajr.152.5.1087

21. Liu L, Shi L, Su Y, Wang K, Wang H. Epidemiological features of spinal intradural tumors, a single-center clinical study in Beijing, China. BMC Musculoskelet Disord 2024; 25(1): 613.
    DOI: https://doi.org/10.1186/s12891-024-07741-2

22. Gupta SK, Gahlot S, Singh R, Singh V. Spinal tumors and tumor-like masses: Relevance of initial imaging, Karnofsky performance status, age, location, and Cord Edema. J Clin Imaging Sci 2019; 9: 21.
    DOI: https://doi.org/10.25259/jcis-24-2019