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Cross Sectional Imaging Modalities (CT & MRI) Distribution in Sohag Governorate in Correlation to Population Distribution

Ahmad Mokhtar Abodahab 1*, Hamdan Abdelhameed Aly 1,
Ahmed Samir Kamel 1, Hisham AbdelGhany 1
1-Radiology Department, Faculty of Medicine, Sohag University, Sohag, Egypt
***Corresponding author:** Ahmad Mokhtar Abodahab **Mobile:** +201004349407, **E-mail**: Ahmed_Abodahab@med.sohag.edu.eg

ABSTRACT

Background: Cross-sectional modalities (computed tomography "CT" and magnetic resonance imaging "MRI") are the highest level of common radiological modalities that are widely used in daily diagnostic medical imaging work all over the world. The distribution of these machines in each country varies according to many factors. Sohag Governorate has one of the highest population numbers in Upper Egypt, extending along 135 km on the River Nile and located at the center between Cairo and Aswan.

Material & Methods: This study aimed to explain the distribution of cross-sectional imaging (CT & MRI) machines in Sohag Governorate, Upper Egypt, in correlation to population distribution in the different cities. The study aimed to be a guide or plan for better radiological services, providing or supporting data for emergency planning against catastrophes.

Results: Sohag Governorate has a total of 67 cross-sectional imaging machines (75% CT and 25% MRI) distributed over 12 cities, with about 60% of them in Sohag City. 2 cities at the same distance (33 km) on both sides of the capital city have the highest numbers of machines.

Conclusion: Imaging modalities are the main key to the diagnosis of a wide range of emergencies and diseases. Cross-sectional imaging modalities are the top of diagnostic imaging modalities. Distribution of these machines in Sohag Governorate is not proportional to the population distribution but correlated to financial factors and distribution of qualified radiologists.

Keywords: Radiological modalities, Cross sectional imaging, CT, MRI, Sohag, Upper Egypt

INTRODUCTION

Cross-sectional imaging modalities, either CT or MRI, are considered the mountaintops of radiology specialty, with the upper hand in the diagnosis of a long list of diseases and emergencies in almost all specialties. In the Covid-19 pandemic, CT chest was the main key for diagnosis and follow-up, with significant variance in services provided according to the number and distribution of machines in different places [(1-7)]. Sohag Governorate (Gerga Governorate before 1960) is one of the Upper Egypt governorates, located about at the center between the capital of Egypt, Cairo—450 km north—and Aswan, the southernmost governorate in Egypt (Figure 1). Its total population represents 5.3% of the total Egyptian population, about 6 million; 52% are males and 48% are females (Figure 2) [(8-11)].

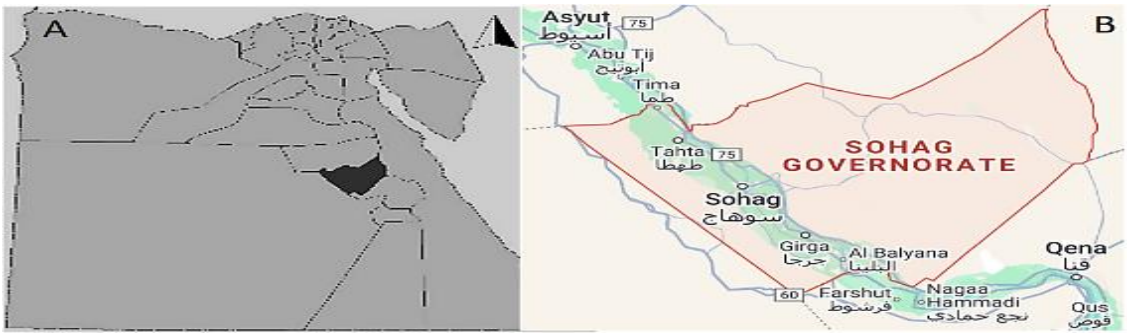

Figure (1): Sohag Governorate A- Location in Egypt and B- Governorate borders and cities (Google Maps).

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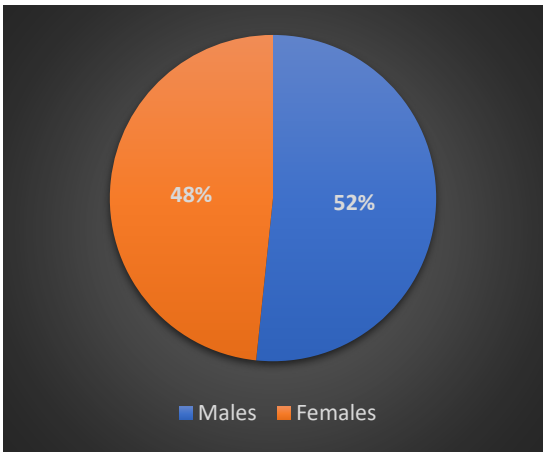

Figure (2): Sohag Governorate population gender distribution.

MATERIAL AND METHODS

This study was targeting to investigate and explain the numbers and distribution of cross-sectional imaging machines (CT and MRI) in Sohag Governorate in correlation to population distribution in its different cities depending on the most recent official and governmental sources of data and direct contact with colleagues in different hospitals for collection of updated full data.

Ethical considerations: This study was not committed on any patients, so it did not require patients informed written consent, while it was approved by The Ethical Committee, Faculty of Medicine, Sohag University.

RESULTS

Sohag Governorate is considered one of the most crowded Egyptian governorates (the 8th out of a total of 27 Egyptian governorates and the 3rd in Upper Egypt after Al-Giza and Al-Minia), with a total population of 5,926,593, according to CAPMS (Central Agency for Public Mobilization and Statistics) in April 2025, distributed among 12 cities of Sohag Governorate and 264 villages (Table 1) (Fig. 3). The total number 67 cross sectional imaging machines, 50 CT & 17 MRI, 68% private and 32% Governmental. 60% of machines are in the capital city Sohag.

The total number of CT machines in the whole governorate is 50 (17 governmental and 33 in private places), while the total number of MRI machines is 17 (5 governmental and 12 in private places). The highest number of both is in Sohag city, the capital of the governorate. Sohag University Hospitals contains the largest number of machines (2 MRI and 5 CT).

Also, it has the highest CT machine slice number (128 slices), which enables cardiac imaging, an important service that wasn't available in the governorate a few years ago. The highest MRI machine regarding its Tesla power is located in Sohag Military Hospital (3 Tesla), while the other machines generally are 1.5 Tesla and less.

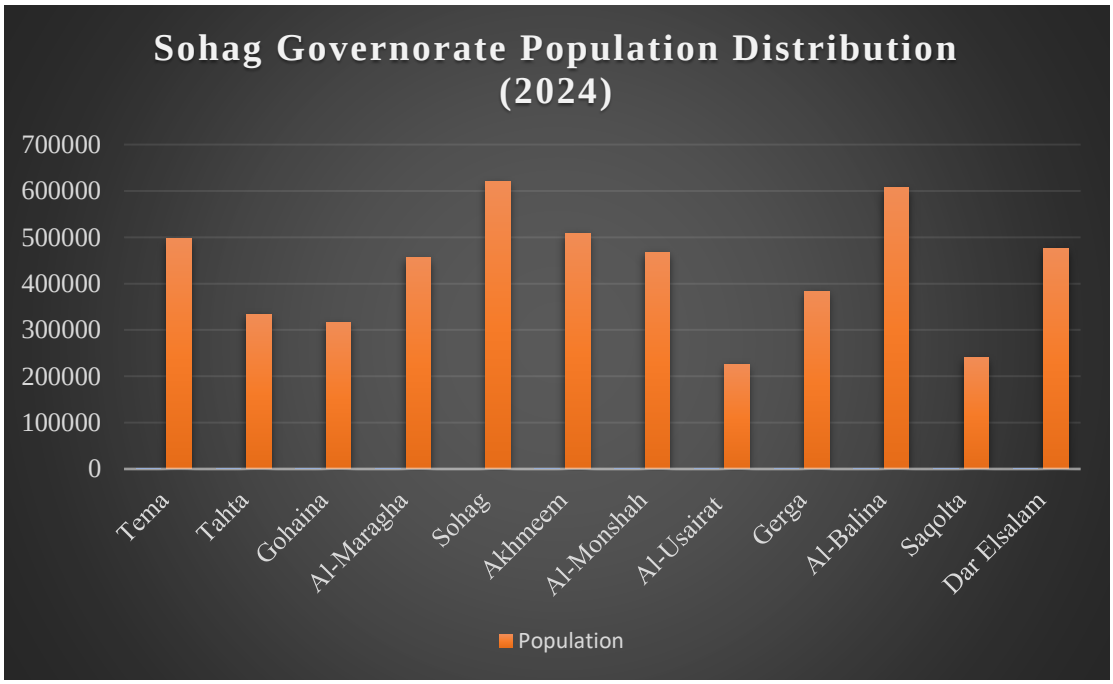

Figure (3): Sohag governorate population distribution.

The number of CT machines is much more than the number of MRI machines in Sohag Governorate (Fig. 4), either due to the higher cost of MRI machines or due to a smaller number of radiologists that have sufficient experience in reporting on its different types of scans.

The distribution of cross-sectional machines in between different cities of Sohag is significantly different, with the least number of machines in cities like Akhmeem and Al-Usairat. 0 MRI and only 1 CT machine in cities like Al-Maragha and Al-Monshah. No village in Sohag contains cross-sectional machines, although some villages have high population numbers and the overall high percentage of rural population (79%) (Fig. 5) in a total number of 264 villages.

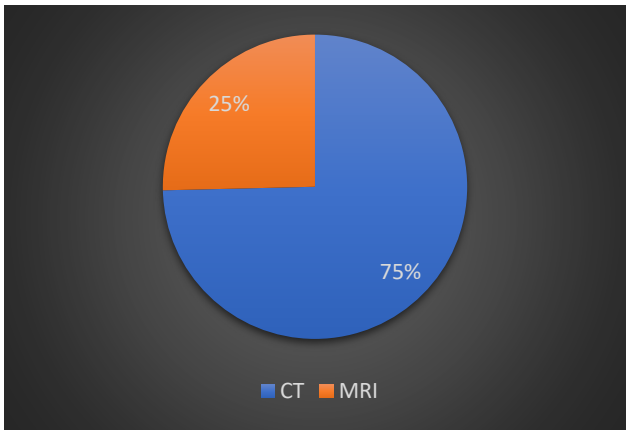

Figure (4): CT versus MRI machines in Sohag Governorate

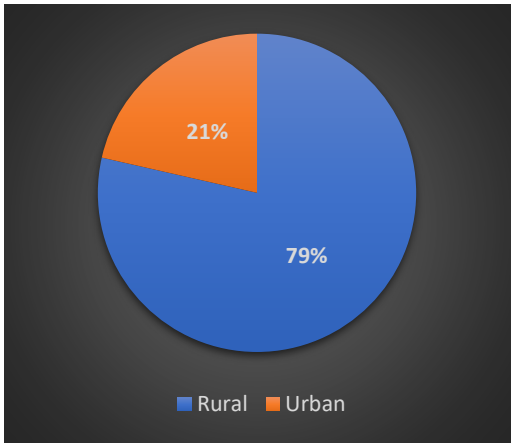

Figure (5): Rural versus urban population distribution in Sohag Governorate.

CT and MRI machines distribution in Sohag Governorate is not proportional to the distribution of population (Sohag Governorate is extended along the river Nile for 135 km) but this is mostly related to the concentrated number of radiologists in the capital city and the relative non long distance of the most far cities either in the north (Tema - 52 km) or the most south (El-Balina 58 km) (Fig.6)The total number of machines in private work is larger in comparison to the governmental hospitals. The distance of each city to Sohag has a role in this distribution (e.g., Akhmeem city has no machines due to its near distance to Sohag, so these services are easily acquired there) (Fig. 7).

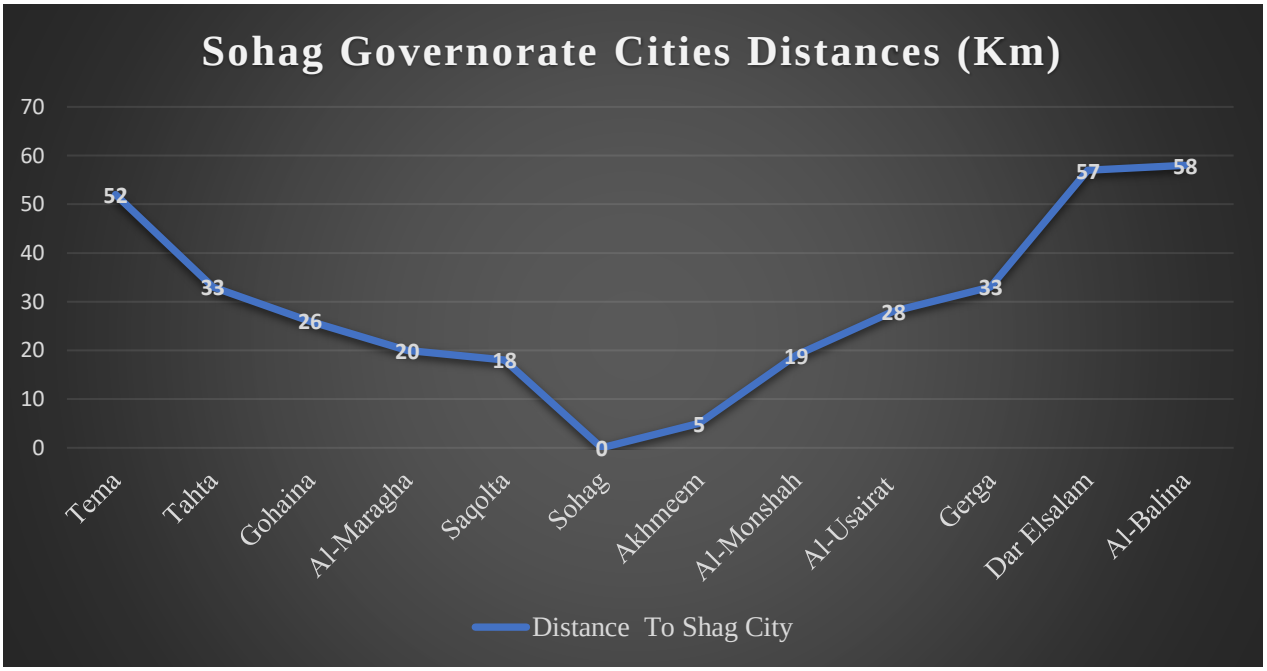

Figure (6): The distances between cities in Sohag governorate

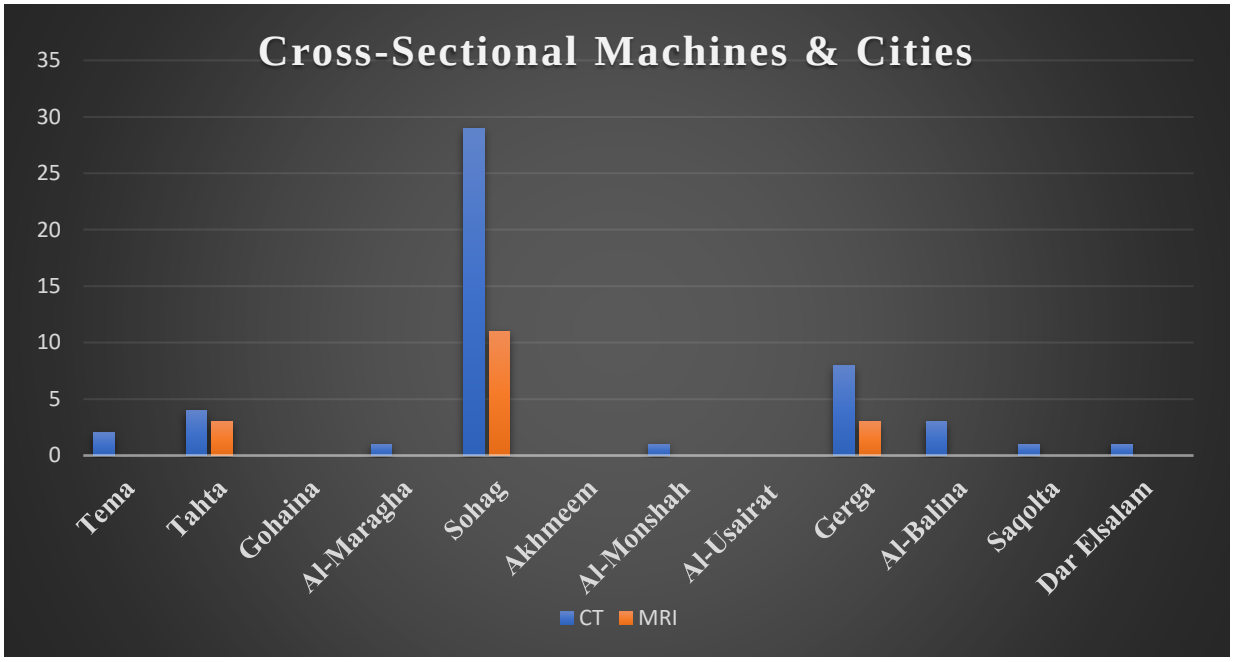

Figure (7): Numbers of CT and MRI machines in different cities in Sohag governorate.

Table (1): Sohag governorate cities, villages, distances and cross-sectional imaging machines numbers and distribution

Machine / CITY	Distance To Sohag (Km)	Total Population	Total Villages	CT			MRI			Both MACHINES TOTAL
				G.	P.	Total	G.	P.	Total	
Tema	52	**496,641**	34	1	1	2	0	0	0	**2**
Tahta	33	**334,028**	28	1	3	4	0	3	3	**7**
Gohaina	26	**315,825**	14	0	0	0	0	0	0	**0**
Al-Maragha	20	**455,893**	23	0	1	1	0	0	0	**1**
Sohag	0	**619,854**	28	13	16	29	5	6	11	**40**
Akhmeem	5	**508,984**	14	0	0	0	0	0	0	**0**
Al-Monshah	19	**467,695**	25	0	1	1	0	0	0	**1**
Al-Usairat	28	**226,216**	10	0	0	0	0	0	0	**0**
Gerga	33	**383,116**	26	1	7	8	0	3	3	**11**
Al-Balina	58	**607,128**	29	1	2	3	0	0	0	**3**
Saqolta	18	**239,966**	14	0	1	1	0	0	0	**1**
Dar Elsalam	57	**475,648**	19	0	1	1	0	0	0	**1**
TOTAL		**5,926,593**	264	**17**	**33**	**50**	**5**	**12**	**17**	**67**

***G** = Governmental Hospitals **P** = Private Hospitals & Clinics

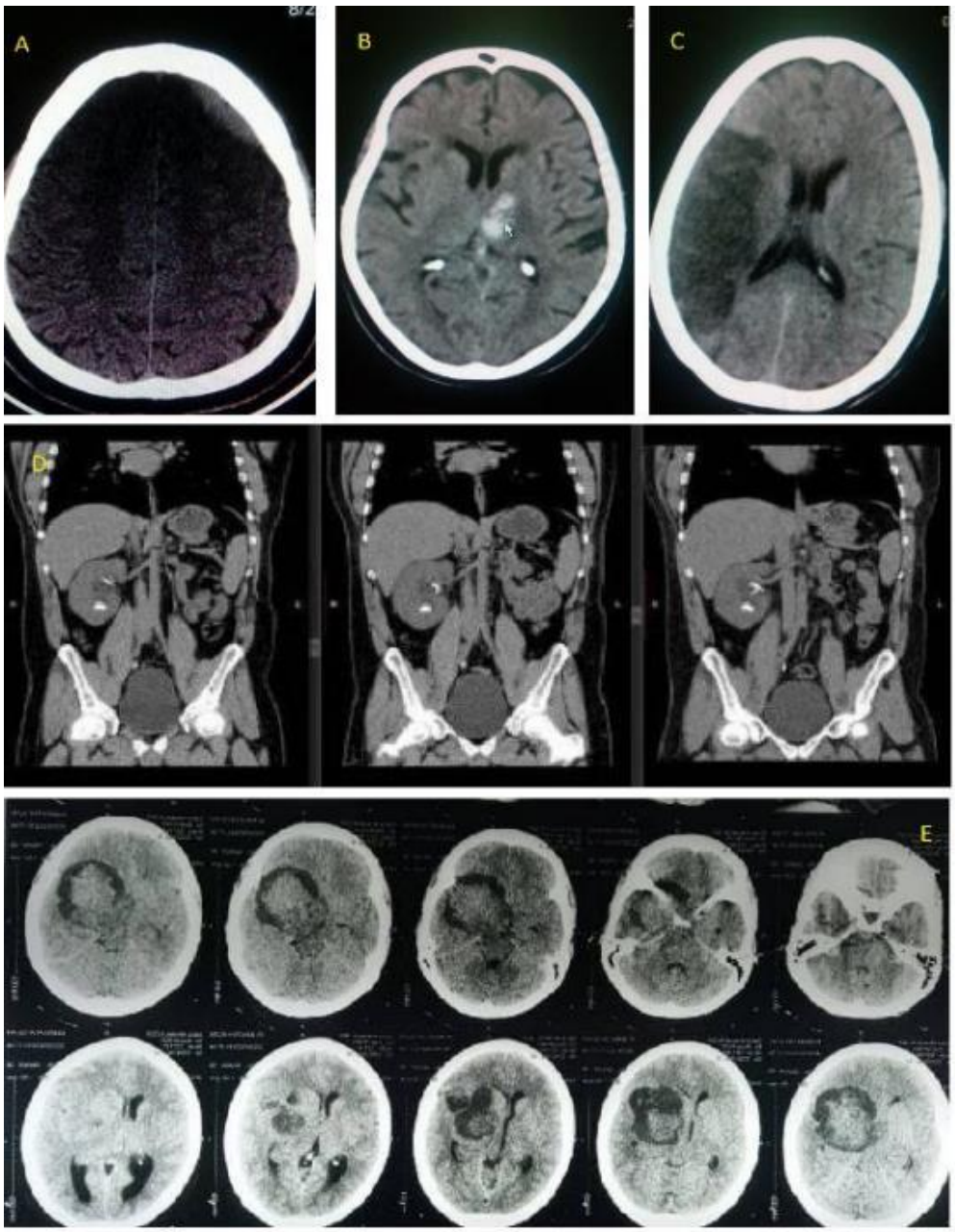

Figure (8): Different examples of cases from our daily workflow that diagnosed mainly by CT Axial non-enhancing CT brain A. Lt frontal epidural hematoma B. Intracerebral hemorrhage C. Rt subacute cerebral infarction D. Coronal reformatted CT of the urinary tract, follow-up scan revealed the same finding of a right lower calyceal stone and ureteric stent. E. Pre-contrast scan of cerebral SOL (space-occupying lesion), with associated mass effect. A post-contrast scan was recommended, but the patient did not complete it due to financial causes.

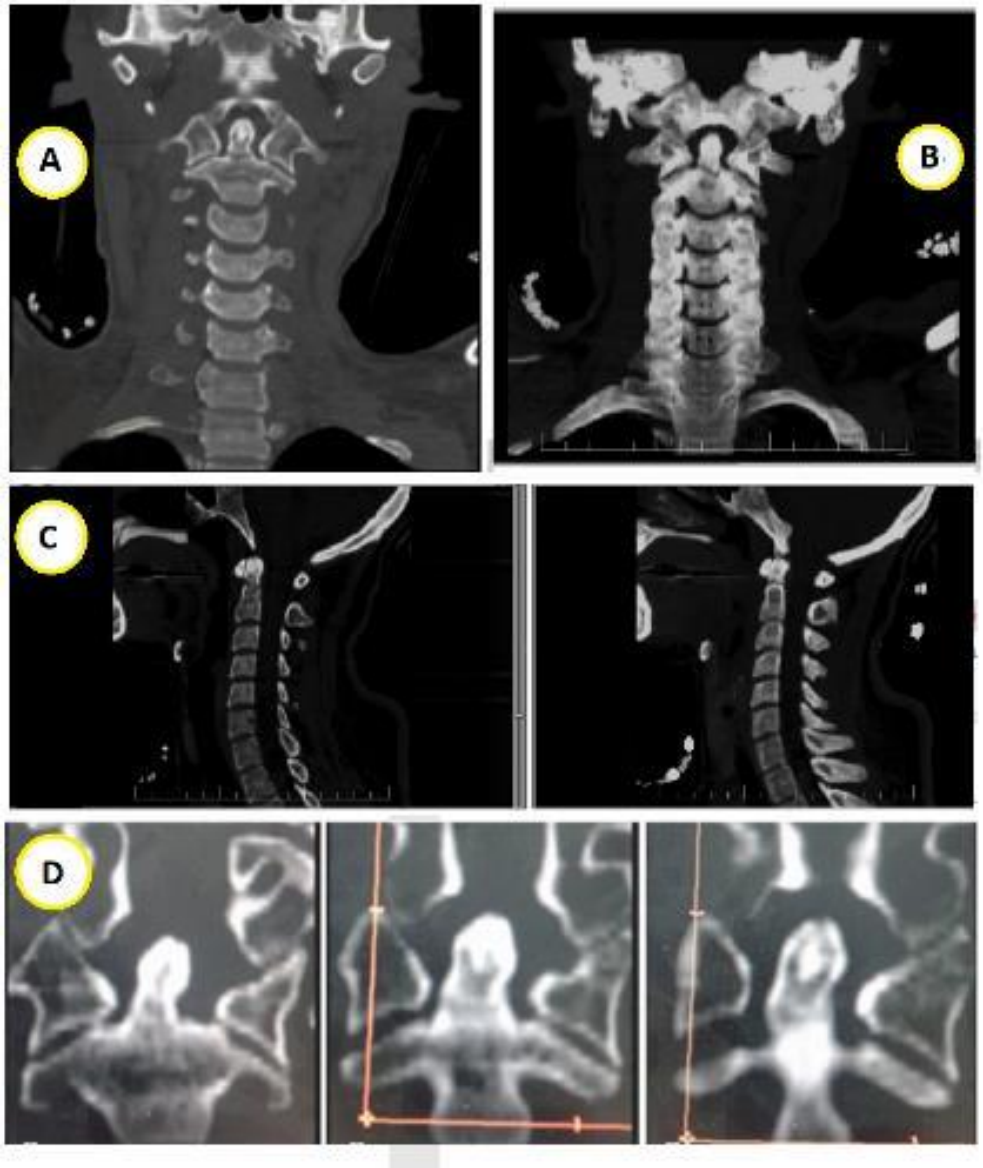

Figure (9): A case of adult female presented in motor case accident with odontoid process fracture type 2 A- Coronal reformate scan B- 3D Coronal reformate scan C- Sagittal reformate scan D- Follow up coronal reformate scan of after healing. The case is published by the corresponding author as a case report [16].

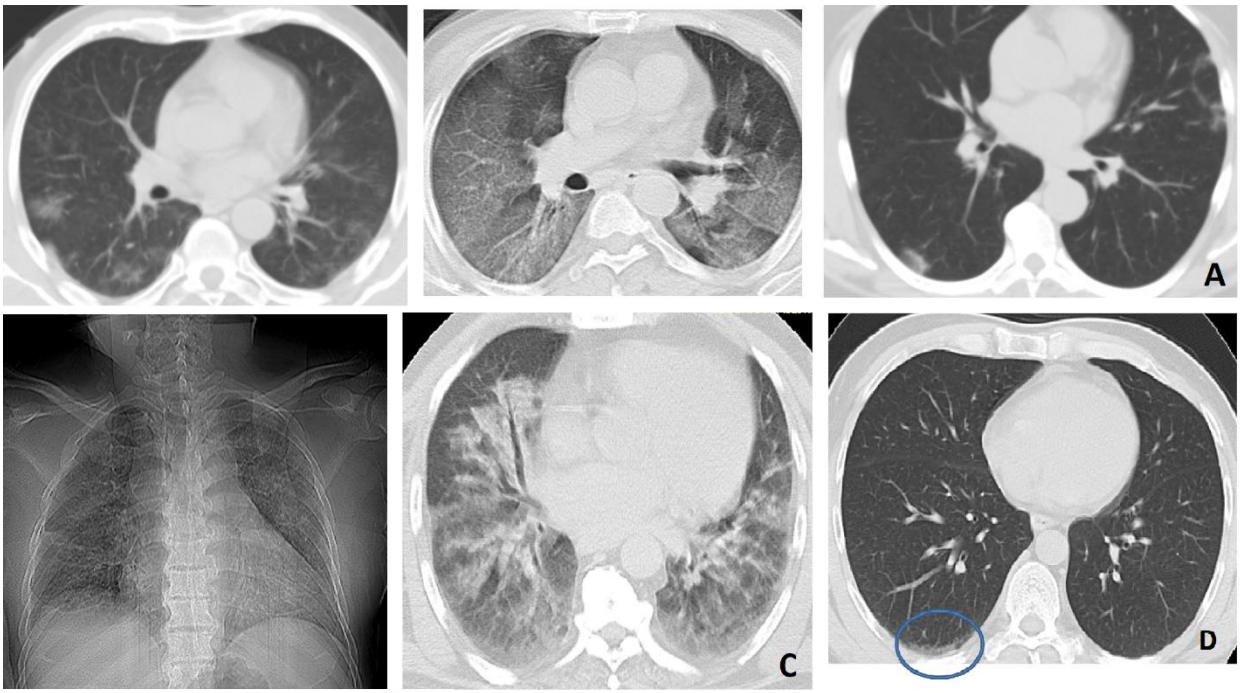

Figure (10): Axial non-contrast CT scans of CT chests of different cases of COVID-19 from work cases in the period of the pandemic: A-—COVID-19 CORADS 4-5 of variable severities, B & C—X-ray and CT scan of severe COVID-19 infection CORADS 5 case, notice how X-ray was deficient in detection of lesions in comparison with CT and D—a case of normal CT chest for a suspected case of COVID-19. The dependent lesions seen at CT are transient non-pathological findings that disappeared when the CT scan was repeated in the prone position.

DISCUSSION

Worldwide, approximately 375 million CT scans are performed each year, while 100-150 million scans, 40 million of them, are performed in the United States only. There are about 345,500 radiologists worldwide, but their distribution is highly unequal, with significant shortages in many countries [11].

This shortage is much more significant in developing and poor countries, subsequently affecting the overall total diagnosed cases per day, even if a significant number of radiological machines are available in this locality. PACS (Picture Archiving and Communication System) and teleradiology are considered now an applicable solution for partial compensation of the total number of deficient radiologists or lack of experience, but within limits related to the experience and the overall number of scans in correlation to the total qualified radiologists who can provide these services at certain times of work. CT is indicated in a wide range of emergencies involving almost all body systems [13, 14].

No doubt that X-ray and US are the basic and initial medical imaging modalities in nearly any emergency according to its nature, but in a major sector of situations, the final diagnosis, or at least provisional diagnosis and follow-up in both conditions, usually and mainly depends on CT (Figure 8, 9 & 10). Different examples of emergency cases diagnosed by CT from our usual workflow. The emergency workflow of CT is extremely larger than MRI. CT is essential and the first step for Diagnosis of CVS, while MRI is indicated in some selected cases of it, as diffusion MRI is the fastest imaging sequence that can detect cerebral infarction as soon as possible.

Traumatology is mainly dependent on CT for accurate assessment of hidden fractures or classification of certain types like maxillofacial trauma, while MRI is the best in assessment of soft tissue injuries (like ligaments and tendons). Vascular imaging is important in both modalities, but MRI has the advantage of making the scan without contrast depending on the blood flow signal void sequence. Also, MRI is mandatory as a 1st choice when CT is contraindicated, either for conditions related to its nature as an ionizing radiation modality or when CT contrast is contraindicated due to patient hypersensitivity or renal impairment, but it is mandatory for diagnosis of brain tumors. So, MRI is the only choice for these cases. In the Covid-19 pandemic, CT was the first and main imaging modality for diagnosis and follow-up, especially with the very limited role of X-ray for detection of all lesions or accurate assessment of their extension, especially when small. The CORAD system of classification of COVID-19 probability and severity was dependent only on CT chest. The role of teleradiology was significantly brightened in these hard times all over the

world, especially under restrictions of movement and a general shortage of the number of radiologists. (Fig.10) explains some cases of COVID-19 in our daily workflow during the pandemic [5, 12-16].

CONCLUSION

Cross-sectional imaging machines are the largest wings of diagnostic imaging in almost all medical specialties. Sohag Governorate has 67 machines, 60% in Sohag City, with no proportion of distribution to the distribution of population in different cities. 2 main cities can be considered as other centers for cross-sectional imaging machines: Tahta at the north & Gerga at the south of Sohag. This can divide Sohag non-officially into 3 sectors regarding the distribution of cross-sectional imaging: Central, north, and south. This sector's consideration should be the guide of any medical emergency planning related to medical imaging. Financial support is mandatory for maintenance and regular work of all radiological modalities, especially CT and MRI, due to expensive mandatory maintenance, as a small board breakdown can stop the work of the whole machine and convert it to an out-of-service tool. Teleradiology is an important solution to equalize the shortage and maldistribution of qualified required radiologists not only in Sohag but in any place all over the world.

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Conflicts of Interest: None.

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