

## Contribution of Radiological Imaging in the Management of Cervical Spine Trauma

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**DOI:** 10.31080/ASMS.2023.07.1484

**Received:** February 06, 2023

**Published:** February 15, 2023

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### Abstract

**Objectives:** The main objective of our work is to study the contribution of radiological imaging in the diagnosis and therapeutic decision in traumatized patients of the cervical spine.

**Materials and Methods:** We conducted an exhaustive descriptive-type study with prospective collection, carried out over a period of three and a half years at the level of several structures of the University Hospital of Tlemcen, namely the emergency service, multipurpose intensive care and neurosurgery departments. It focused on cervical spine trauma patients treated from the scene of the accident to the neurosurgery and / or medical-surgical resuscitation departments. All patients admitted for cervical spine trauma, whether superior (C0-C2), inferior (C3-C7) or mixed, whatever the mechanism of the accident, whatever the treatment decision, with or without neurological lesions, with or without signs of seriousness on admission and over 16 years of age.

**Results:** The majority of the injured (n = 107) benefited from a CT scan of the cervical spine at the University Hospital of Tlemcen (83.59%) upon admission, while 7.81% (n = 10) did so privately. 8.59% (n = 11) had their CT examination a few days after their hospitalization in the Neurosurgery department (7 at the central radiology unit of the university hospital of Tlemcen and 4 in an external radiology structure). The CT scan allowed us to accurately diagnose the osteoarticular lesion and to guide our therapeutic conduct. Of the 21 patients who presented spinal cord compression, 15 were of bone origin (11.71%), 4 of disc origin (3.12%) and two others of mixed origin (1.6%). A single vascular lesion of the vertebral artery was recorded during the study (1.6%). The damage to the recorded ligaments represented 7.81% with a frequency of ligament rupture of the order of 4.7% and a frequency of ligament elongation of the order of 3.12%. Spinal cord edema and intraspinal hematoma were successively around 6.25% and 2.34%.

**Conclusion:** In the acute phase of the trauma, it retains performance inferior to that of CS in the detection of minor bone lesions, but equivalent to dynamic maneuvers to search for instabilities of ligament origin access to the machine and the cost are far superior. In addition, the indication will have to be very carefully weighed in polytrauma patients because of the difficulties of monitoring during this sometimes very long examination and the need to use equipment resistant to magnetic fields (respirator, etc.). The scanner therefore remains the most effective technique for detecting but also formally eliminating a traumatic lesion.

**Keywords:** Cervical Spine Trauma; CT Scan; MRI; Tlemcen

### Introduction

The lack of specificity of the clinical signs obliges the clinician to systematically resort to imaging, without forgetting that the risk of

ignoring an unstable cervical lesion could have dramatic functional consequences [1].

The latest generation CT scans (multi-slice) allow analysis in thin sections very quickly and the realization of multi-planar

reconstructions increasing the diagnostic sensitivity (study of the posterior wall) [2].

His interest is the search for all bone lesions and a detailed analysis of them.

MRI is more effective for exploring spinal or disco-ligamentous lesions and soft tissues [3]; in particular, those characteristic within the anterior soft tissues, hematoma, ligament, and disc or even dural rupture.

Nevertheless, the validity of the examination for the diagnosis of ligament lesions is questionable because the ligaments are commonly not visualized in healthy subjects.

For some authors, it should be performed before any reduction or stabilization maneuver so as not to miss a disc fragment that could become compressive after these gestures [4].

## Materials and Methods

Our research work carry out an exhaustive descriptive type of study with prospective collection, carried out over a period of three and a half years extending from July 2013 to December 2016 at the level of several structures at the University Hospital Center of Tlemcen, including medical and surgical emergency services, multi-purpose resuscitation and neurosurgery.

It emphasizes on the cervical spine trauma patients treated from the scene of the accident to the neurosurgery and/or medico-surgical resuscitation departments at the University Hospital Center, where, all admitted for cervical spine trauma, whether superior (C0-C2) or inferior (C3-C7) or mixed, whatever the mechanism of the accident, whatever the therapeutic decision (surgical or orthopedic), with or without neurological lesions, with or without signs of seriousness on admission and over 16 years of age.

We excluded from our study all subjects with other associated traumatic spinal injuries, namely dorsal, lumbar and/ or sacral.

## Results

Almost all of the patients (n = 104) benefited from standard x-ray images (81.25%) of the cervical spine with an initial radiological assessment including at least a front and side view, which most often allowed us to make an initial assessment.

45.31% benefited from an open mouth C1-C2 radiography.

Standard radiographs were normal despite the existence of neurological disorders in 21 patients (16.40%).

Dynamic X-rays were taken in six patients (4.68%), between 10 and 15 days after the cervical trauma, showing for two of them a severe sprain and for four others, a mild sprain.

The majority of the injured (n = 107) benefited from a CT scan of the cervical spine at the Tlemcen University Hospital (83.59%) upon admission, while 7.81% (n = 10) did so privately.

8.59 % (n = 11) had their CT examination a few days after their hospitalization in the Neurosurgery department (7 at the central radiology unit of our university hospital and 4 in an external radiology structure).

The CT scan allowed us to accurately diagnose the osteoarticular lesion and to guide our therapeutic conduct.

**Histogram 1:** Distribution of cervical CT examination.

## Depending on place and time

The anatomopathological lesions diagnosed through the study of the various imaging examinations were listed according to the cervical level concerned by the traumatic lesion(s).

Distribution of CT lesions at the level of the cervical spine injury (CSI):

A fracture of C1 and C2 dominated the upper level lesions.

13.28 % of the injured (n = 17) had presented an Atlas fracture. Nine affecting the post arch, 1 the anterior arch, 4 both arches, and

three the lateral masses (two unilateral and 1 bilateral). 3.12% had an odontoid fracture (n = 4), including two at the base.

The other patients had a severe sprain of C1 C2 (2 cases), a fracture of the spinous processes of C2 (3 cases), an uniarticular fracture of the Axis (1 arc), and of the post blade of C2 (3 cases) (Table 1).

Upper CSI	Workforce	Percentage
C0	1	0,78
Dislocation C0 C1	0	0
Fracture C1	17	13,28
Dislocation C1 C2	3	2,34
Fracture of the odontoid	4	3,12
C2 body fracture	10	7,81
C2 bipedicular fracture	5	3,90
Others	9	7,03

**Table 1:** Distribution of CT lesions at the level of the CSI.

The C1-C2 hinge was more affected by the trauma (24.21%) than the C0-C1 hinge (14.06%) as indicated in table 2 (See metameric level).

Level reached	Number	Percentage %
C0-C1	18	14,06
C1-C2	31	24,21

**Table 2:** Hinge reached CSI.

Distribution of CT lesions at the level of the lower cervical spine (LCS):

35.93 % of joint dislocations (n = 46) were reported in our study (19 were uni-articular and 27 bi-articular).

Whatever the section plane, the body fractures were revealed in their entirety, while the dislocations were clearly visible on the sagittal sections, a little less on the frontal sections and not visible on the axial sections.

The other lesions were subluxations, mainly of C4-C5 and C2-C3.

LCS injury	Workforce	Percentage
Simple fracture of the body	27	21,09
Fracture-crush of vertebral body	10	7,81
Fracture-comminuted of vertebral body	5	3,90
Uni and bilateral joint dislocation	46	35,93
Tear Drop fracture	18	14,06
Severe sprain	10	7,81
Mild sprain	8	6,25
Fractures-dislocations	21	16,40
Fracture separation of the articular mass	12	9,37
Spinous fracture	12	9,37
Blade fracture	26	20,31
Post traumatic disc herniation	9	7,03
Others	11	8,59

**Table 3:** Distribution of CT lesions at the level of the LCS.

Injury to the C6 and C5 cervical vertebrae was the most common in the study as shown in table 4.

Vertebrae	C3	C4	C5	C6	C7
Number	7	10	35	44	19
Percentage	5,46 %	7,81%	27,34%	34,37%	14,84%

**Table 4:** Distribution of lesions according to the vertebra affected.

It emerged from our study that the C5-C6 and C4-C5 hinges were the most vulnerable following trauma with a successive frequency of 26.56% and 18.75% (Table 5).

Hinge reached	Number	Percentage %
C2-C3	3	2,34
C3-C4	9	7,03
C4-C5	24	18,75
C5-C6	34	26,56
C6-C7	21	16,04
C7-D1	4	3,12

**Table 5:** Distribution of LCS lesions according to the affected hinge.

MRI of the cervical spine was performed in only 29 patients (22.65%), with T1 and T2 sequences, which were systematically performed in a sagittal plane and in axial and coronal section.

allowed a detailed diagnosis of spinal cord injury looking for spinal contusions, epidural hematoma, compressive herniated discs, etc.

### Type of lesions found on spinal MRI

Most of the MRI examinations of the 29 patients took place within 48 hours of the patient's admission to the medical-surgical emergencies department. Only two examinations were performed on the 7<sup>th</sup> and 8<sup>th</sup> day.

The patients who benefited from a cervical MRI are those who had presented a radio-clinical discrepancy.

Of the 21 patients who presented spinal cord compression, 15 were of bone origin (11.71%), 4 of disc origin (3.12%) and two others of mixed origin (1.6%).

A single vascular lesion of the vertebral artery was recorded during the study (1.6%).

The damage to the recorded ligaments represented 7.81% with a frequency of ligament rupture of the order of 4.7% (n = 6) and a frequency of ligament elongation of the order of 3.12% (n = 4).

Spinal cord edema and intraspinal hematoma were successively around 6.25% (n = 8) and 2.34% (n = 3).

Seven cases (n=7) of cervicarthrotic myelopathy decompensated by trauma, severe cord angulation on neglected cervical trauma and cavitation with myelomalacia.

**Histogram 2:** Type of lesions found on spinal MRI.

### Discussion

In our study, 81.25% of patients (n = 104) benefited from standard X-ray images (SC) and about 1/4 benefited from an open mouth C1-C2 X-ray.

The sensitivity of CS in detecting vertebral lesions is variable. According to a retrospective study directed by WOODRING and LEE [5] on 213 patients, the radiographs miss 23% of the fractures, half of which would be unstable.

NUNEZ and QUENCER [6] indicate that up to 57% of lesions may be overlooked, moreover the variety of spinal lesions (25 to 30% of cases) and the lack of specific clinical signs should lead to an exploration of the entire cervical spine [7] in order to analyze the bone lesions, their compressive nature, to assess the degree of instability and to decide on the operating time.

In our series, this figure was lower since 16.40% had lesions that had gone unnoticed. Due to the lack of availability of MRI, the scanner was the dominant imaging examination performed in 89.06% of our patients, so we were unable to establish with certainty the diagnosis of spinal cord contusion in some patients and which diagnostic MRI [3,8] is.

The dose of irradiation delivered during the CT examination is much higher than that emanating from standard X-rays (19.5 against 6.4 m SV) and the image acquisition time is longer for CT (40 against 33 minutes) [9], which makes it an excellent examination in the absence of an MRI.

In the ROMULUS, *et al.* series [10], 97.7% of TRCs had benefited from cervical CT against 10.3% from MRI only.

The study by KHOUDIR and ZENATI [11] found a similar frequency, namely that only 5% of the injured (n = 2) had been transferred to the MRI room of the Bejaïa hospital, compared to 95% of CT scans carried out (n = 39).

A discrepancy just as obvious as that found in previous studies was reported by BOUTARBOUCH, *et al.* [12] with equally lower results from MRI examinations (12.3%), compared to 84.2% from CT examinations.

In these three series, a standard radiological assessment was performed in 100% of the patients.

On the other hand, the practice of MRI at the UHC of Tlemcen was more important than in the previous series, since 22.65% of hospitalized patients benefited from this examination on their admission. In reality, the exact percentage was higher (25%) because the MRI was only operational from February 2015 (16 cases/ out of 64 admissions in the two years 2015-2016), the rest of the patients (n = 13) did it privately.

This low frequency of performance of MRI in certain studies seems to be linked to a lack of equipment in several hospitals for this essential tool during the radiological diagnosis of cervical spinal cord lesions, but sometimes also to a lack of qualified radiologists in this specific field, which was the case in Tlemcen.

BOHLMAN [13] reported on a series of 300 fractures of the cervical spine, 100 cases that had not been initially diagnosed clinically and/or radiologically, with delays in diagnosis ranging from one day to one year. RINGENBERG [13] also notes the lack of initial diagnosis in 7% of his patients hospitalized for trauma to the cervical spine.

Also, it is important to specify during the radiological assessment another group of patients at risk, carriers of degenerative disorders (rheumatoid arthritis, ankylosing spondylitis, psoriatic arthritis) or congenital disorders (trisomy 21, neurofibromatosis) causing sometimes decompensated cervical instabilities during minor traumas [14].

In addition, some authors such as DORAN, *et al.* [15] have pointed out the interest of MRI before and after reduction, in order to study the disc, especially since it allows direct visualization of the marrow without recourse to a contrast medium [16].

Cervical spinal MRI was rarely performed in our patients in Tlemcen for several reasons, the main ones being its unavailability during a long period of the study.

This examination was then only done by appointment in the central radiology unit of the medical-surgical emergencies of Tlemcen (only on days weeks), and waiting times were often too long, prompting neurosurgeons to settle for a cervical CT examination that is more easily performed at the medical-surgical emergencies department.

## Conclusion

Cervical spine trauma are responsible of severe functional consequences representing a significant cost to society and a faint hope in social reintegration.

MRI allows an accurate assessment of traumatic spinal cord damage and extra medullary. Spinal cord injuries are the most common followed by disc injuries, dislocations and ligament ruptures.

It remains a capital contribution in the assessment of prognosis but also in neurosurgical decisions.

Ligament lesions are often unrecognized and should be systematically sought by dynamic X-rays. These can be performed remotely from the trauma.

However, in the acute phase of the trauma, it retains performance inferior to that of CS in the detection of minor bone lesions, but equivalent to dynamic maneuvers to search for instabilities of ligament origin access to the machine and the cost are far superior.

In addition, the indication will have to be very carefully weighed in polytrauma patients because of the difficulties of monitoring during this sometimes very long examination and the need to use equipment resistant to magnetic fields (respirator, etc.). The scanner therefore remains the most effective technique for detecting but also formally eliminating a traumatic lesion.

## Conflict of Interest

The authors have stated that there is no conflict of interest.

## Acknowledgments

We are thankful for all the practicing physicians of the Neurosurgery and Anesthesia-Intensive care department of Tlemcen University Hospital, who participated in the care of cervical spine trauma patients and in the collection of data:

- **Internal Doctors:** In particular Rajaa Hebri who had done a remarkable job.
- **Medical Staff:** Mohammed Nedjraoui and Amina Bendahmane.
- **Paramedical Staff:** Mrs. Khalida HadeF, Mr. Madani El Hadj and all the nurses in the department and physiotherapists. All dedicated and very well organized in the rotation of the guards.

- **University Hospital Departments:** Professor. Mohamed Si Saber (Neurosurgery), Professor. Rachida Djerfaoui (Anesthesia - Intensive care), Professor. Meriem Bouteflika (Radiology), Professor. Katia Taouli (Hemobiology) Algeria.
- **International teams:** A special thanks to Professor. Frederic Aubrun (Croix-Rousse Hospital) and Professor. Anne-Marie Schott Pethelaz (Hesper Laboratory) from France, who helped me to finalize this work.

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