Cairo University
Faculty of Medicine
Department of Radiodiagnosis

# Role of Multi-Detector Computed Tomography (MDCT) in the evaluation of postoperative spine with orthopedic hardware

Thesis
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**By**

**Khaled Abd EL Baky Ahmed EL Hannan**
M.B.B.Ch., M.Sc
Faculty of Medicine, Mansoura University

Supervised by

**Prof. Dr. SALWA MOHAMED FATHY ISMAIL**
**Professor of Radiology**
**Faculty of Medicine**
**Cairo University**

**Prof. Dr. YOUSRY MOHAMED KAMAL EL HAWARY**
**Professor of orthopedic surgery**
**Faculty of Medicine**
**Cairo University**

**Dr. MANAR HUSSEIN ABD EL SATTAR**
**Assist. Professor of Radiology**
**Faculty of Medicine**
**Cairo University**

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# List of Abbreviations

| | |
|---|---|
| **AP** | Antero-posterior |
| **C.S** | Cervical spine |
| **CT** | Computed tomography |
| **FOV** | Field of view |
| **HU** | Hounsfield unit |
| **Kv** | Kilovoltage |
| **L.S** | Lumbar spine |
| **mAs** | Miliamber |
| **MDCT** | Multi-detector computed tomography |
| **MIP** | Maximum intensity projection |
| **MPRs** | Multiplanar reconstructions |
| **MRI** | Magnetic resonance imaging |
| **T.S** | Thoracic spine |
| **VRT** | Volume rendering technique |

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Keyword

MDCT- orthopedic- Kv- T.S

**Abstract**

*Objective:* To assess the role of multi- detector computed tomography (MDCT) in the evaluation of postoperative spine with orthopedic hardware in comparison to the routine conventional plain radiography.

*Material and Methods*: This prospective study included 50 patients with postoperative spine. All subjects were evaluated by conventional radiography and MDCT. Volumetric raw data were acquired in the helical mode (16 slices per tube rotation) with thin collimation and were transferred from the PACS to a separate dedicated post-processing workstation. All patients were evaluated for spine bony fusion, malplacement of pedicular screws and other complications.

*Results*: A statistically significant difference was found between MDCT and conventional radiography in the evaluation of bone fusion and malplacement screws. Compared to re operating surgical findings, MDCT identified eight malplaced screws while radiography detects five screws.

*Conclusion:* Multi- detector computed tomography (MDCT) was valuable in the evaluation of postoperative spine with orthopedic hardware in comparison to the routine conventional plain radiography.

# INTRODUCTION AND AIM OF THE WORK

## Introduction

Computed tomography (CT) historically has held a central role in musculoskeletal (MSK) imaging as a result of its ability to evaluate a large number of bony lesions accurately. In more recent years, magnetic resonance imaging (MRI), with its ability to produce multi-planar imaging and its improved characterization of the soft tissue, has played an increasing central role. However, CT retains an important place in MSK imaging, which has increasing further with the advent of multi - detector computed tomography (MDCT) and its ability to produce near isotropic voxels allowing for multiplanar reformats(MPRs) and faster data acquisition. CT has obvious advantages over MRI in the imaging of acute trauma, but also may have other advantages, such as in the imaging of post operative patient. Unlike MRI, there is few, if any, absolute contra indication to CT **(West et al, 2009)**.

Evaluating the spine in patients with metal orthopedic hardware is challenging. Although the effectiveness of conventional computed tomography (CT) can be limited by severe beam-hardening artifacts, the evolution of multichannel CT in recent years has made available new techniques that can help minimize these artifacts. Multichannel CT allows faster scanning times, resulting in reduced motion artifacts; thinner sections, with which it is possible to create a scanned volume of isotropic voxels with equivalent image resolution in all planes; and the generation of a higher x-ray tube current, which may result in better penetration of metal hardware and reduction of artifacts. Although 140 kVp and high mill amperage-second exposure are recommended for imaging patients with hardware, caution should always be exercised, particularly in children, young adults, and patients undergoing multiple examinations. The acquisition of multiplanar reformatted images in the axial, sagittal, coronal, and oblique planes and of three-dimensional volume-rendered images optimizes image interpretation. Wide window settings are best for reviewing images when hardware is present. The integrity of hardware is best assessed with multiplanar average intensity projection **(Douglas-Akinwande et al, 2006)**.

Postoperative imaging of the spine is performed for ***(a)*** routine assessment of patients with a good clinical outcome or ***(b)*** assessment of recurrent or intractable pain **(Sanders and Truumees, 2004)**.

After spinal fusion surgery, imaging is routinely performed to evaluate for the development of pseudoarthrosis or to determine the degree of spinal fusion. This information is used as a guide for the initiation of physical therapy and the elimination of restrictive bracing **(Sanders and Truumees, 2004)**.

The use of CT for monitoring the progression of inter body fusion is now common at many centers. Thin-section reconstructed CT scans, especially the reformatted coronal and sagittal images, have been demonstrated to show fusion maturation and bone growth and have been effective in fusion evaluation. The scatter effect from second-generation metal devices has not been found to be a significant obstacle when using thin-section CT **(Cook et al, 2004)**.

Potential post surgical complications such as nonunion, osteolysis, infection, and heterotopic ossification are all well assessed by 3D CT **(Fayad et al, 2009).**

## The aim of the work

The aim of this work is to assess the role of multi- detector computed tomography (MDCT) in the evaluation of postoperative spine with orthopedic hardware in comparison to the routine conventional plain radiography, clinical and surgical outcome.

# ANATOMY

The structural unit of the spine is the vertebra. There are 33 vertebrae in the human spine: 7 cervical, 12 thoracic, 5 lumbar, 5 sacral, and 4 coccygeal **(fig 1)**. The 5 sacral vertebrae are fused and form a composite bone, the sacrum, and the 4 coccygeal vertebrae are usually fused to form the coccyx (**Mathis, 2006*)***.

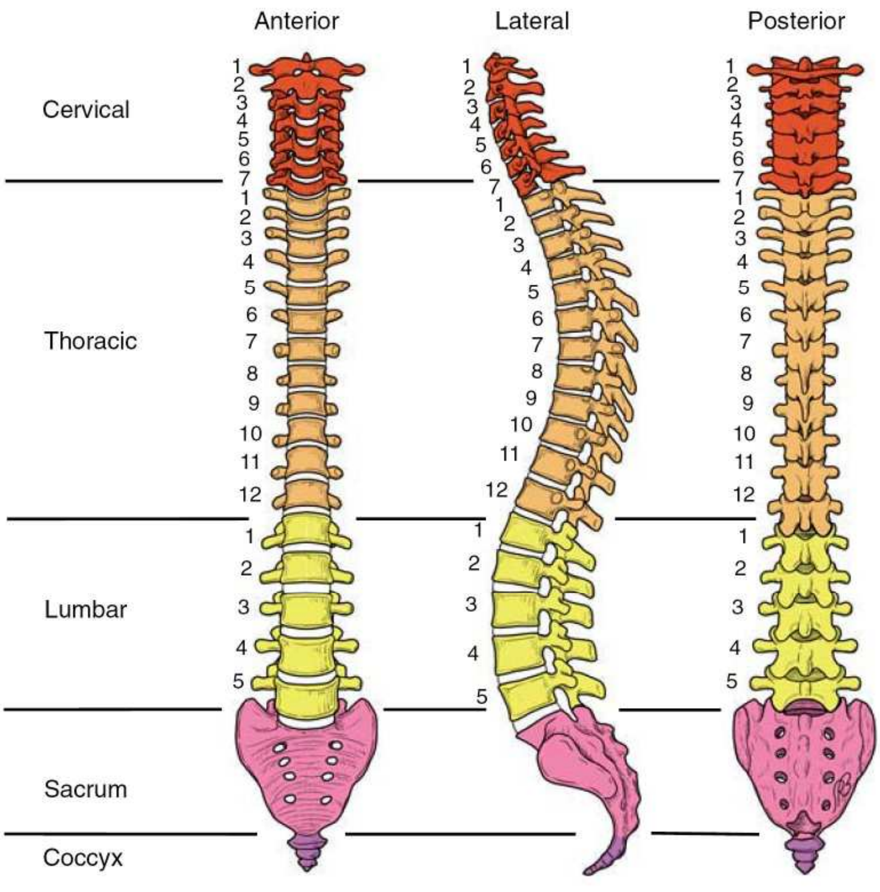


**Fig. (1)** Anterior, lateral and posterior depictions of the entire spine. The lateral view shows the normal lordotic curve found in the cervical and lumbar regions. A kyphotic curve is normal in thoracic and sacral regions. These curves can be modified or accentuated in disease **(Mathis, 2006)**.

# TYPICAL VERTEBRAE

A typical vertebra consists of a body and an arch. The body is classified as a long bone with a waist like diaphysis, or shaft, situated between two endplates, or epiphyses. The heights of the vertebral bodies increase from the cervical to the lumbar regions, reflecting the fact that the bodies carry the weight of the trunk, upper limbs, and head ( **Dephilip and McGraw, 2004).**

The vertebral arch consists of two pedicles, two laminae, and seven processes. The pedicles project posteriorly from the vertebral body and reach the laminae. There are three processes at the junction of the pedicle and its corresponding lamina. A transverse process projects laterally and acts as a lever and attachment point for intrinsic muscles of the back. A superior articular process projects superiorly and articulates with the inferior articular process of the vertebra above. Similarly, an inferior articular process projects inferiorly and articulates with the superior process of the vertebra below. The pars interarticularis is the isthmus of bone between the superior and the inferior articular processes. The laminae meet posteriorly in the midline at the spinous process. The continuous ring of bone formed by the posterior aspect of the vertebral body, the two pedicles, and the two laminae create the vertebral foramen. When the 33 vertebrae are in articulation, the superimposed vertebral foramina form the vertebral canal ( **Dephilip and McGraw, 2004).**

## 1- Cervical Vertebrae

Cervical vertebrae are distinguished by foramina in their transverse processes that transmit the vertebral artery and associated sympathetic nerve plexus, and the vertebral vein **(Fig 2)**. The spinous processes of C2–C7 are bifid and the transverse processes have anterior and posterior tubercles. The vertebral foramina are large to accommodate the large diameter of the cervical spinal cord and to permit extensive movement ( **Dephilip and McGraw, 2004).**

The first cervical vertebra is a ring of bone containing two lateral masses connected by anterior and posterior arches. The anterior arch displays a tubercle on its anterior aspect for attachment of the anterior longitudinal ligament and the longus capitis muscle. A facet on its posterior aspect articulates with the odontoid process of the axis. The posterior arch displays a posterior tubercle for muscle attachment and grooves on either side for the horizontal portion of the vertebral artery ( **Dephilip and McGraw, 2004).**

The distinguishing feature of the C2 vertebra is its odontoid process or dens. Each lateral mass of the axis has a superior articulating surface to receive the inferior articulating surface of the atlas and an inferior articulating surface to meet the superior articulating process of C3. Its spinous process is large and bifid, being the attachment point for intrinsic muscles of the back, namely the semispinalis cervicis and the inferior oblique muscle of the suboccipital triangle ( **Dephilip and McGraw, 2004).**

The spinous process of C7 is the first that can be palpated in the midline of the neck, earning the C7 vertebra the name vertebra prominens ( **Dephilip and McGraw 2004).**

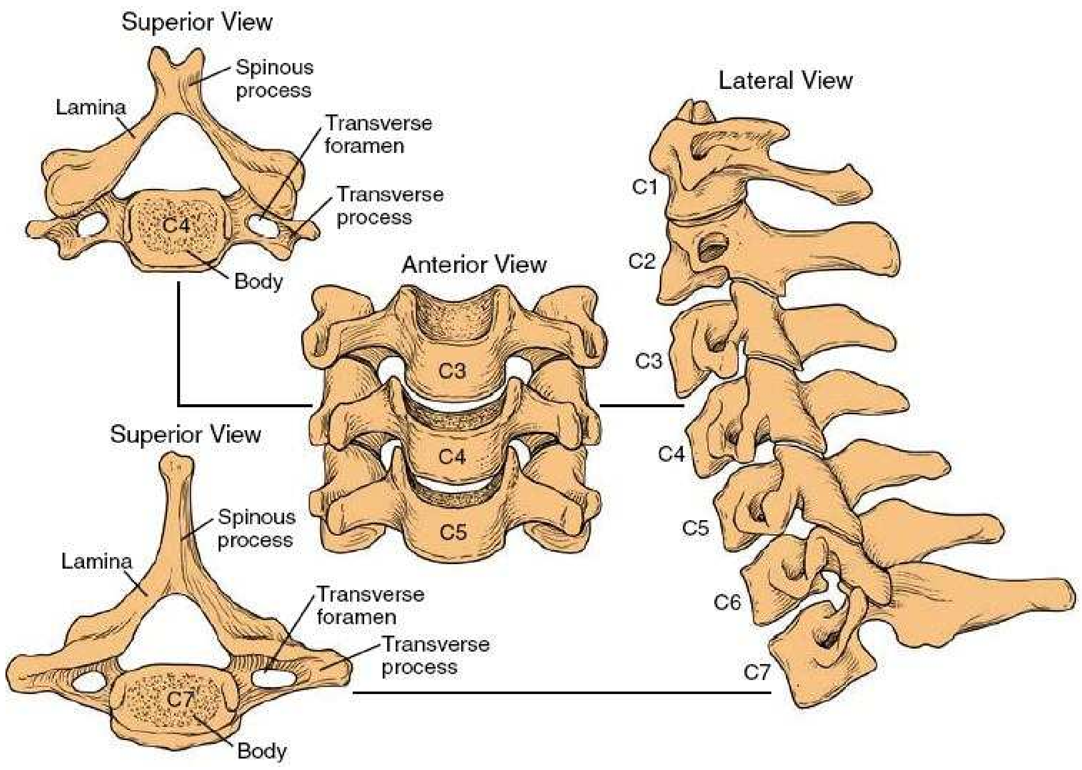


Fig 2. Cervical vertebrae **(Mathis, 2006)**.