INTRODUCTION

Approximately 5-10% of post traumatic patients have major injury to the cervical spine. Cervical spine injuries cause an estimated 6000 deaths and 5000 new cases of quadriplegia each year. Most cervical spine fractures occur predominantly at 2 levels. One third of injuries occur at the level of axis (C2), and one half of injuries occur at the level of C6 or C7. Most fatal cervical spine injuries occur in upper cervical levels, either at craniocervical junction, C1 or C2 **(Winslow JE 3rd et al., Sep 2006).**

The normal anatomy of the cervical spine consists of 7 cervical vertebrae separated by intervertebral disks and joined by a complex network of ligaments. These ligaments keep individual bony elements behaving as a single unit. The cervical spine considered as 3 distinct columns: anterior, middle, and posterior. Column disruption may lead to mechanical instability of the cervical spine. The degree of instability depends on several factors that may translate into neurologic disability due to spinal cord compression **(Hockberger et al., 1998).**

Cervical spine injuries are best classified according to several mechanisms of injury. These include flexion, flexion-rotation, extension, extension-rotation, vertical

compression, lateral flexion injuries **(Jacobs and Schwartz, Jan 1986).**

Clinical evaluation of the cervical spine in a patient with blunt trauma is unreliable. In a study of surgical residents' ability to predict cervical injuries on the basis of clinical examination alone, sensitivity and specificity were 46% and 94%, respectively. Most patients with complex blunt trauma seen in the ED undergo radiographic evaluation before clearance, and some may need further evaluation by CT scan and MRI **(Duane et al., Jun 2007).**

Management of cervical spine fractures starts by minimize neck movement during transport to the treating facility. Ideally, transport the patient on a backboard with a semi rigid collar, with the neck stabilized on the sides of the head with sand bags or foam blocks taped from side to side (of the board), across the forehead.

Management of cervical spine fractures varies according to type of fracture, instability and presence of cord compression from external fixation to surgical decompression and internal fixation **(Nordin et al., 2008).**

AIM OF THE WORK

Review current and recent modalities of conservative and surgical management of cervical spine fractures.

ANATOMY OF THE CERVICAL SPINE

Knowledge of cervical spine anatomy, normal alignment and biomechanics is important for the understanding of all aspects of clinical analysis and management of cervical spine problems, the cervical spine may be divided into an upper cervical region and a lower cervical region **(Savas, 2003).**

The cervical spine consists of the following components:

Osseous component

Ligaments and Joints

Spinal cord

▪ The osseous component of the cervical spine

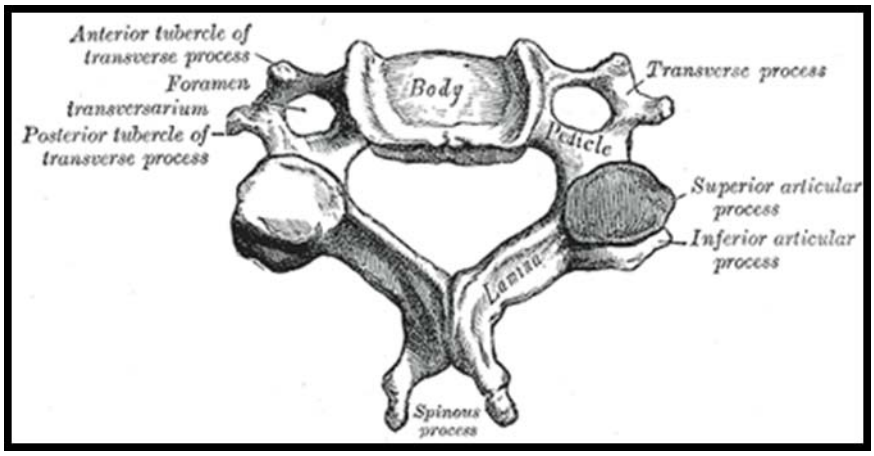

Fig. (1): A cervical vertebra (**Putz and Pabst, 1997).**

Cervical vertebrae are the smallest of the true vertebrae, and can be readily distinguished from those of the thoracic or lumbar regions by the presence of a foramen in each transverse process. The first, second, and seventh present exceptional features and must be separately described; the following characteristics are common to the remaining four. The body is small and broader from side to side than from before backward. The anterior and posterior surfaces are flattened and of equal depth; the former is placed on a lower level than the latter, and its inferior border is prolonged downward, so as to overlap the upper and forepart of the vertebra below. The upper surface is concave transversely, and presents a projecting lip on either side; the lower surface is concave from before backward, convex from side to side, and presents laterally shallow concavities which receive the corresponding projecting lips of the subjacent vertebra. The pedicles are directed lateral ward and backward, and are attached to the body midway between its upper and lower borders, so that the superior vertebral notch is as deep as the inferior, but it is, at the same time, narrower. The lamina are narrow, and thinner above than below; the vertebral foramen is large, and of a triangular form. The spinous process is short and bifid, the two divisions being often of unequal size. The superior and inferior articular processes on either side are fused to form an articular pillar, which projects lateral ward from the junction of the pedicle and lamina. The articular facets are

flat and of an oval form: the superior look backward, upward, and slightly medial ward: the inferior forward, downward, and slightly lateral ward. The transverse processes are each pierced by the foramen transversarium, which, in the upper six vertebras, gives passage to the vertebral artery and vein and a plexus of sympathetic nerves. Each process consists of an anterior and a posterior part. The anterior portion is the homologue of the rib in the thoracic region, and is therefore named the *costal process* or costal element: it arises from the side of the body, is directed lateral ward in front of the foramen, and ends in a tubercle, the anterior tubercle. The posterior part, the *true transverse process*, springs from the vertebral arch behind the foramen, and is directed forward and lateral ward; it ends in a flattened vertical tubercle, the posterior tubercle. These two parts are joined, outside the foramen, by a bar of bone which exhibits a deep sulcus on its upper surface for the passage of the corresponding spinal nerve **(Abrahams et al., 2002).**

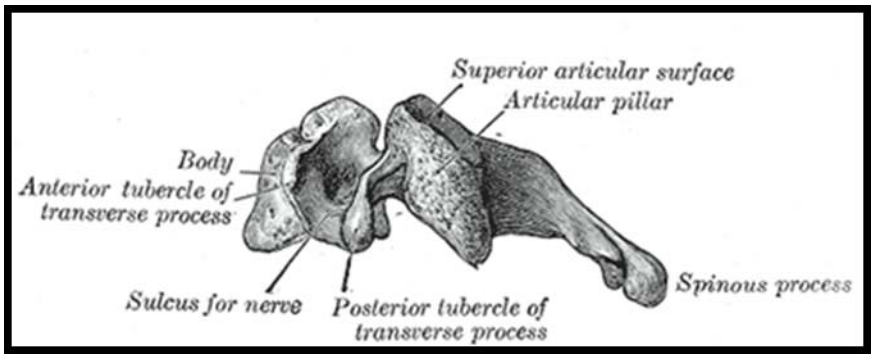

Fig. (2): Side view of a typical cervical vertebra (**Putz and Pabst, 1997).**

First Cervical Vertebra, the first cervical vertebra is named the *atlas* because it supports the globe of the head. Its chief peculiarity is that it has no body, and this is due to the fact that the body of the atlas has fused with that of the next vertebra. Its other peculiarities are that it has no spinous process, is ring-like, and consists of an anterior and a posterior arch and two lateral masses. The anterior arch forms about one-fifth of the ring: its anterior surface is convex, and presents at its center the anterior tubercle for the attachment of the Longus colli muscles; posteriorly it is concave, and marked by a smooth, oval or circular facet (*fovea dentis*), for articulation with the odontoid process (*dens*) of the axis. The upper and lower borders respectively give attachment to the anterior atlantooccipital membrane and the anterior atlantoaxial ligament; the former connects it with the occipital bone above, and the latter with the axis below. The posterior arch forms about two-fifths of the circumference of the ring: it ends behind in the posterior tubercle, which is the rudiment of a spinous process and gives origin to the Recti capitis. The diminutive size of this process prevents any interference with the movements between the atlas and the skull. The posterior part of the arch presents above and behind a rounded edge for the attachment of the posterior atlantoöccipital membrane, while immediately behind each superior articular process is a groove (*sulcus arteriæ vertebralis*), sometimes converted into a foramen by a

delicate bony spiculum which arches backward from the posterior end of the superior articular process. This groove represents the superior vertebral notch, and serves for the transmission of the vertebral artery, which, after ascending through the foramen in the transverse process, winds around the lateral mass in a direction backward and medialward; it also transmits the suboccipital (first spinal) nerve. On the under surface of the posterior arch, behind the articular facets, are two shallow grooves, the inferior vertebral notches. The lower border gives attachment to the posterior atlantoaxial ligament, which connects it with the axis. The lateral masses are the most bulky and solid parts of the atlas, in order to support the weight of the head. Each carries two articular facets, a superior and an inferior. The superior facets are of large size, oval, concave, and approach each other in front, but diverge behind: they are directed upward, medial ward, and a little backward, each forming a cup for the corresponding condyle of the occipital bone, and are admirably adapted to the nodding movements of the head. Not infrequently they are partially subdivided by indentations which encroach upon their margins. The inferior articular facets are circular in form, flattened or slightly convex and directed downward and medialward, articulating with the axis, and permitting the rotatory movements of the head. Just below the medial margin of each superior facet is a small tubercle, for the attachment of the transverse atlantal ligament which

stretches across the ring of the atlas and divides the vertebral foramen into two unequal parts—the anterior or smaller receiving the odontoid process of the axis, the posterior transmitting the medulla spinalis and its membranes. This part of the vertebral canal is of considerable size, much greater than is required for the accommodation of the medulla spinalis, and hence lateral displacement of the atlas may occur without compression of this structure. The transverse processes are large; they project lateralward and downward from the lateral masses, and serve for the attachment of muscles which assist in rotating the head. They are long, and their anterior and posterior tubercles are fused into one mass; the foramen transversarium is directed from below, upward and backward **(Crossman and Neary, 2002).**

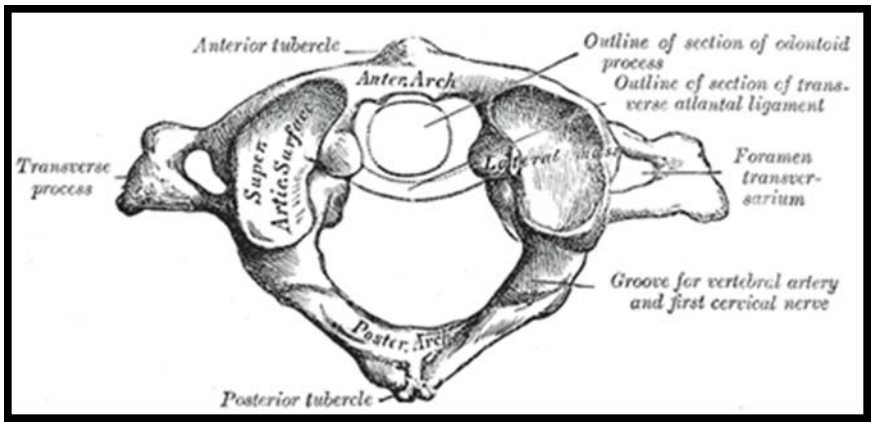

Fig. (3): First cervical vertebra, or atlas (**Putz and Pabst, 1997).**

Second Cervical Vertebra, the second cervical vertebra is named the *epistropheus or axis* because it forms the pivot upon which the first vertebra, carrying the head, rotates. The most distinctive characteristic of this bone is the strong odontoid process which rises perpendicularly from the upper surface of the body. The body is deeper in front than behind, and prolonged downward anteriorly so as to overlap the upper and fore part of the third vertebra. It presents in front a median longitudinal ridge, separating two lateral depressions for the attachment of the Longus colli muscles. Its under surface is concave from before backward and convex from side to side. The dens or odontoid process exhibits a slight constriction or neck, where it joins the body. On its anterior surface is an oval or nearly circular facet for articulation with that on the anterior arch of the atlas. On the back of the neck, and frequently extending on to its lateral surfaces, is a shallow groove for the transverse atlantal ligament which retains the process in position. The apex is pointed, and gives attachment to the apical odontoid ligament; below the apex the process is somewhat enlarged, and presents on either side a rough impression for the attachment of the alar ligament; these ligaments connect the process to the occipital bone. The internal structure of the odontoid process is more compact than that of the body. The pedicles are broad and strong, especially in front, where they coalesce with the sides of the body and the root of the

odontoid process. They are covered above by the superior articular surfaces. The lamina are thick and strong, and the vertebral foramen large, but smaller than that of the atlas. The transverse processes are very small, and each ends in a single tubercle; each is perforated by the foramen transversarium, which is directed obliquely upward and lateral ward. The superior articular surfaces are round, slightly convex, directed upward and lateral ward, and are supported on the body, pedicles, and transverse processes. The inferior articular surfaces have the same direction as those of the other cervical vertebra. The superior vertebral notches are very shallow, and lie behind the articular processes; the inferior lie in front of the articular processes, as in the other cervical vertebra. The spinous process is large, very strong, deeply channeled on its under surface, and presents a bifid, tuberculated extremity, of this vertebra is the existence of a long and prominent spinous process, hence the name vertebra prominence. This process is thick, nearly horizontal in direction, not bifurcated, but terminating in a tubercle to which the lower end of the ligamentum nuchae is attached **(Ellis et al., 1999).**

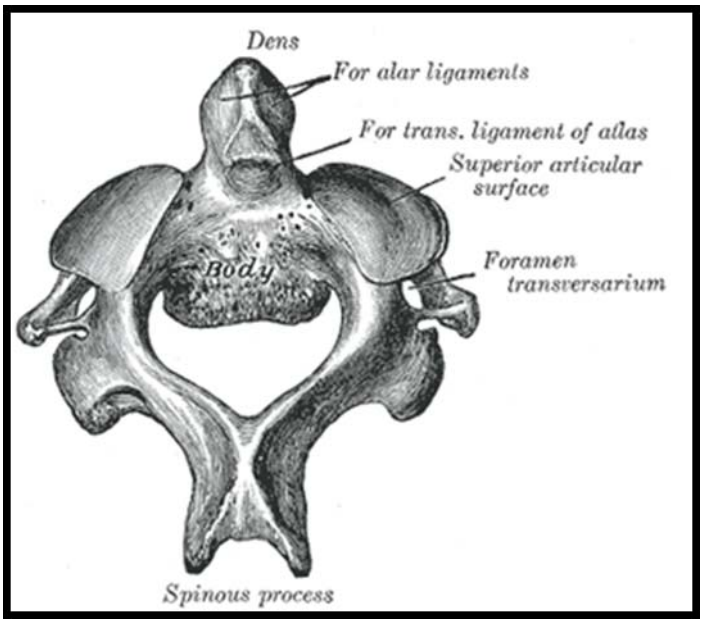

Fig. (4): Second cervical vertebra, or epistropheus, from above (**Putz and Pabst, 1997).**

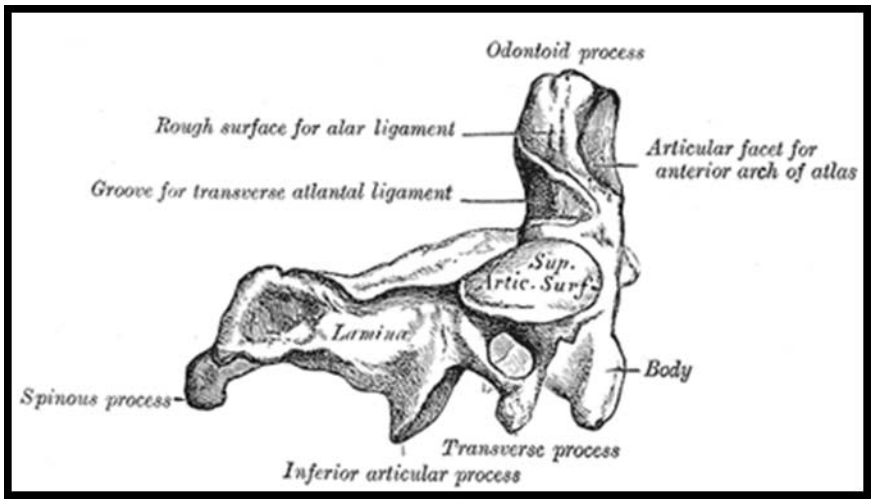

Fig. (5): Second cervical vertebra, epistropheus, or axis, from the side (**Putz and Pabst, 1997).**

The Seventh Cervical Vertebra, The most distinctive characteristic is the transverse processes which are of considerable size, their posterior roots are large and prominent, while the anterior are small and faintly marked;

the upper surface of each has usually a shallow sulcus for the eighth spinal nerve, and its extremity seldom presents more than a trace of bifurcation. The foramen transversarium may be as large as that in the other cervical vertebra, but is generally smaller on one or both sides; occasionally it is double, sometimes it is absent. On the left side it occasionally gives passage to the vertebral artery; more frequently the vertebral vein traverses it on both sides; but the usual arrangement is for both artery and vein to pass in front of the transverse process, and not through the foramen. Sometimes the anterior root of the transverse process attains a large size and exists as a separate bone, which is known as a cervical rib **(Panjabi et al., 1993**)

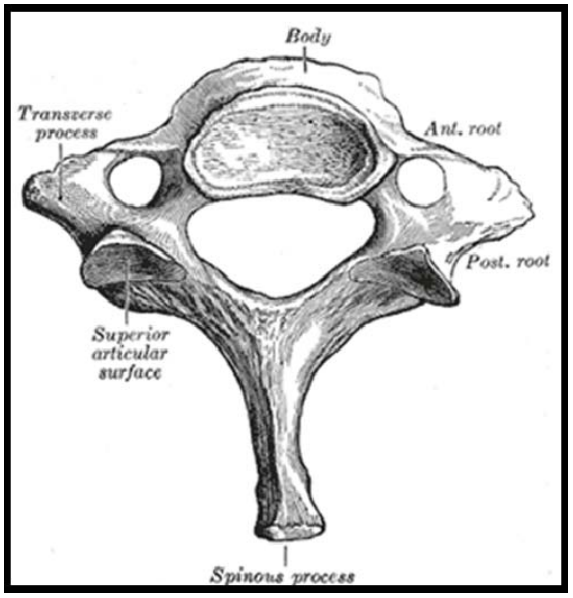

Fig. (6): Seventh cervical vertebra (**Putz and Pabst, 1997).**

▪ Ligaments and Joints

Ligamentum nuchea

The ligamentum nuchae is a bilaminar fibro elastic intermuscular septum which is often considered homologous with, but structurally distinct from, the supraspinous and interspinous ligaments in the neck. Its dense bilateral fibro elastic laminae are separated by a tenuous layer of areolar tissue and the laminae are blended at its posterior free border. This border is superficial and extends from the external occipital protuberance to the spine of C7. There is also a midline attachment to the posterior spinal dura at atlanto-occipital and atlanto-axial levels **(Berkovitz et al., 2002).**

▪ Anterior longitudinal ligament

The anterior longitudinal ligament is a strong band extending along the anterior surfaces of the vertebral bodies. It is relatively thicker and narrower opposite vertebral bodies than at the levels of intervertebral symphyses. It extends from the basilar part of the occipital bone to the anterior tubercle of C1 and the front of the body of C2, and then continues caudally to the front of the upper sacrum. Its longitudinal fibers are strongly adherent to the intervertebral discs, hyaline cartilage end-plates and margins of adjacent vertebral bodies, and are loosely attached at intermediate levels of the bodies, where the

ligament fills their anterior concavities, flattening the vertebral profile **(Panjabi, et al., 1993).**

- **Posterior longitudinal ligament**

The posterior longitudinal ligament lies on the posterior surfaces of the vertebral bodies in the vertebral canal, attached between the body of C2 and the sacrum, and continuous with the membrana tectoria above. Its smooth glistening fibers, attached to intervertebral discs, hyaline cartilage end-plates and adjacent margins of vertebral bodies, are separated between attachments by basivertebral veins and the venous rami which drain them into anterior internal vertebral plexuses. Its superficial fibers bridge three or four vertebrae, while deeper fibers extend between adjacent vertebrae as perivertebral ligaments, which are close to and, in adults, fused with, the annulus fibrosus of the intervertebral disc. The layers are more distinct in the immediate postnatal years **(Clausen et al., 1997).**

- **Ligamenta flava**

The ligamenta flava connect laminae of adjacent vertebrae in the vertebral canal. Their attachments extend from facet joint capsules to the point where laminae fuse to form spines. Here their posterior margins meet and are partially united; the intervals between them admit veins which connect the internal and posterior external vertebral venous plexuses. Their predominant tissue is yellow elastic