"ATLAS AND AXIS" THROUGH THE EYES OF THE TRANSORAL SURGEON

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SUMMARY :

Patients with anterior pathology in the atlanto-axial region who present as neurological emergencies require urgent brain-stem decompression. Anterior decompression remains the only alternative to progressive tetraplegia and a fatal outcome. In this study, the anatomical, embryological ad surgical pathological literature is reviewed through the eyes of the transoral surgeon, in order to provide a safe approach to the atlas and axis.

KEY WORDS :

Atlas, Axis, Transoral Surgery.

GROSS ANATOMY

In Greek mythology a titan who supported the earth on his shoulders (1,24) and Atlas was also the first cervical vertebra, (Fig 1) articulating with occipital bone and rotating around the dens of the axis, Atlas differs from the other cervical vertebrae being ringshapes and lacking a vertebral body and a spinous process. It consists simply of two lateral masses united by an anterior and a posterior arch. The body is represented by the dens, a tooth-like projection from the superior surface of the body of C2. The anteror arch forms about one-fifth of the ring: Its anterior surface is convex, and presents about its centre a tubercle for the attachment of the Longus Colli muscles. The posterior arch is convex backward, and has a median posterior tubercle and a groove on the lateral part of upper-outer surface in which the vertebral artery courses. The first cervical spinal nerve also lies in the groove, which is located between artery and bone. The superior is concave and faces downwards and medialy. An inward projestion from each lateral mass given attachment to the transverse ligament which divides the vertebral foramen into a small anterior compartment for the dens, and a larger, oval posterior compartment for the medulla and its coverings. The upper surface of each lateral mass has an oval concave facet that faces upward ad medially, and articulates with the occipital condyle. The inferior surface of each lateral mass has a circular, flat, or slightly concave facet that faces downward, medially and slightly backward and articulates with the superior articular facet of the axis. The upper and lower borders give attachment to the anterior atlanto-occipital and the anterior atlanto-axial ligaments which connect it with the occipital bone above and the axis below. The transverse process lies lateral to the atricular processes. Each transverse foramen, with transmits a vertebral artery, and upon which the nerve root sits, is situated between the lateral mass and the transverse process (5,8,9,18).

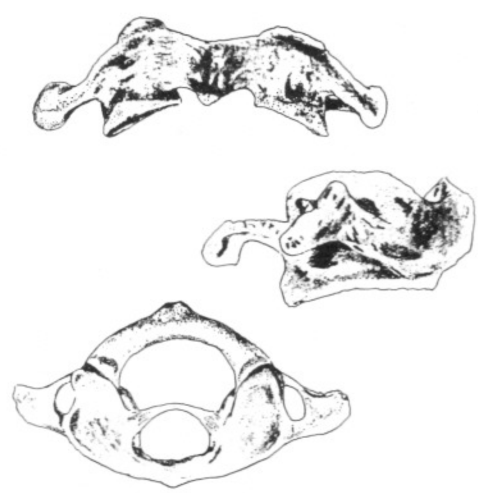

Fig 1 : Atlas, diagrammatic anterior, lateral and superior view

The axis is so named from forming the pivot upon which the first vertebra, carrying the head, rotates (Fig 2). The most distinctive character of the axis is the strong, prominent "odontoid process" or "dens" which projects upward from the body. The apex of the dens is attached to the lower and of the apical ligament, and the alar ligaments are attached to its sides. The odontoid process presents two articulating surfaces : One in front, of oval form, articulation with the atlas, (Fig 3) another behind for the transverse ligament, the latter frequently encroaching on the sides of the process. The internal structure of the odontoid process is more compact that of the body. The anterior aspect of the body is hollowed out on each side of the midline in the area where the Longus Colli muscles attach. The lamina is thick and strong and the spinal foramen large, but smaller than that of the atlas. Tle transverse processes of the axis are small, not bifid and perforated by the foramen for the vertebral artery, which is directed obliquely upward and outward. The vertebral foramen of the axis is somewhat smaller than that of the atlas. The spinous process is large, very strong, deeply channelled on its under surface, and presents a bifid, tubular extremity for the attachment of muscles which serve to rotate the head upon the spine, (15,18,20).

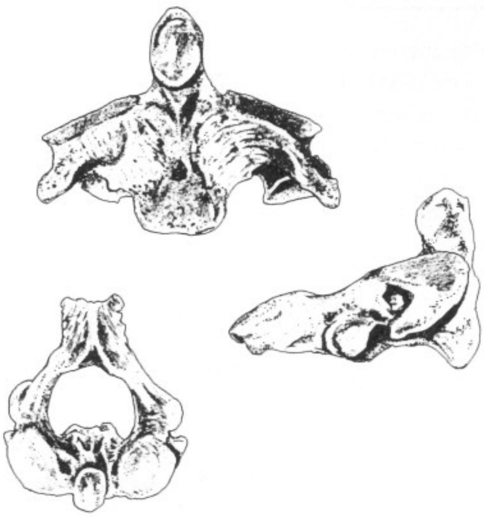

Fig 2 : Axis, diagrammatic anterior, lateral and superi or view

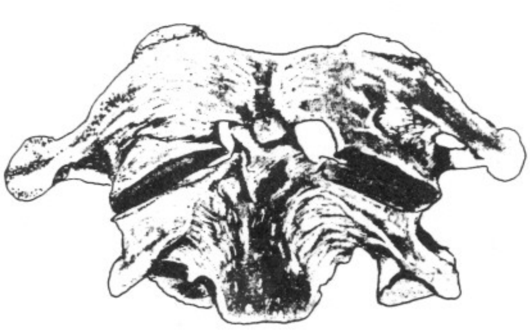

Fig 3 : Atlanto-axial junction, diagrammatic anteri or view

EMBRYOLOGY :

In the human embryo the postotic mesenchyme undergoes some degree of segmentation, with the appearance of somites. The somites in the neck and body differentiate into three portions:

1. A lateral and superficial epithelial plaque, the dermatome, which forms the dermis and adjacent subcutaneous tissues,

2. A lateral but deeper mass, the myotome, which forms the muscles, and

3. A medial and ventral mass, the sclerotome, which forms the vertebrae and intervertebral discs. (1,10,17,19,21). The first spinal somite is called the proatlantal or suboccipital somite, since the nerve supplies the suboccipital mucsles, The main part of the odontoid process is formed from the suboccipital sclerotome (proatlantal sclerotome) together with the posterior half of the second spinal sclerotome (the atlantal sclerotome) (Fig 4).

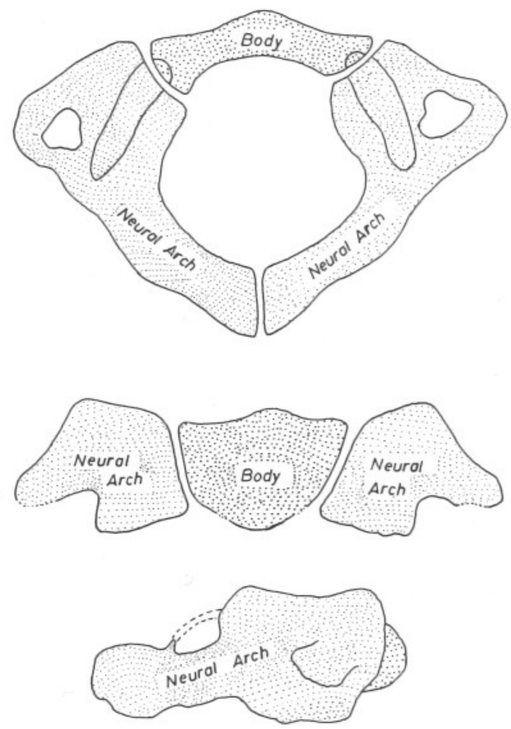

Fig 4 : Developmental components of the first cervical verte bra (atlas) (Redrawn from Silverman)

The axis is formed from the anterior halves of the first and second spinal sclerotomes and the posterior dense half of the first spinal sclerotome (Fig 5). The third occipital sclerotome has a caudal scleromere with fairly well-developed neural and chondal processes. Incomplete incorportain of this scleromere in the basiocciput is considered to cause manifestation of an occipital vertebra or vertebralization of the occiput (22).

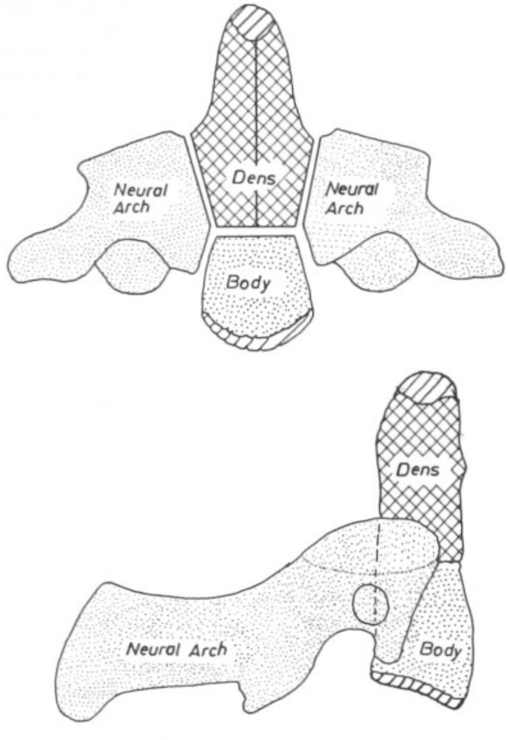

Fig 5 : Developmental elements in the second cervical vertebra (axis) (Redrawn from Silverman)

SURGICAL PATHOLOGY.

The etiology of craniovertebral anbormalities is diverse and may be congenital, inflammatory, acquired, or traumatic. These aetiologies may occur singly or in combination resulting in neurological deficit form compression or ischaemia at the cervicomedullary junction (2,6,13,14,23).

Abnormalities at the atlas and axis may involve only the bones and joints or only the meninges and nervous system, or both systems together. The age at which symptoms result from congenital abnormalites at the craniovertebral junction varies depending to some extent on the type of lesion. In patients with the Chiari malformation, symptoms usually develop at birth or in early life and present little difficulty in diagnosis. Congenital lesions of bone and joint do not usually produce symptoms until adult life. These lesions may be misdiagnosed as multiple sclerosis, primary syringomyelia, or even disc disease. Even when the crevical region is under suspicion, anomalies of the craniovertebral junction may be missed, unless this area is carefully inspected on the x-ray and additional views in flexion and extension are obtained (2,3,12,16,28).

Absence or hypoplasia of the odontoid process occurs in several skeletal dysplasiad, particularly spondylo-epiphyseal dysplasia congenita and Morquio disease.

Although instability is considered infrequent in many instances not associated with skeletal dysplasia, reports of neurological complications and death are sufficiently common in patients with skeletal dysplasia to warrant careful clinical observation and caution, particularly under circumstances such as endotracheal anesthesia, when hyperextension of the head and neck is likely. It is worth noting again that atlanto-axial instability can occur with a normal odontoid when ligamentous structures gare lax, as in Down's syndrome (11). Dawson and Smith point out that atlanto-axial subluxation may occur with incompetence of either the dens or the transverse axial ligament (6).

One structural abnormality of the dens is its appearance as an accessory ossicle moving with the body of C2, the os odontoideum. Early reports classified it as a malformation in which bony union between this cenre (arising from the proatlas) and the body of the atlas fails to occur. More recently, it has been considered an acquired lesion secondary to fracture of the odontion, and numerous instances o this sequence of events have been reported. Von Torklus and Gehle (26), however, strongly support the congenital origin of the os odontoideum on the basis of its deviation in shape from that of the usual odontoid process, although they do not deny that acuired separations can occur. Changes in shape of an obviously fractured segment have been observed and attributed to interference with the blood supply to the dens following the injury. Support for this concept comes from the observation by Treadwell and O'Brien (27) that avascular necrosis of the proximal portion of the dens is a complication of halopelvic distraction. They postulated that ligament disruption interferes with the blood supply to tho dens.

However the observations of Stevens et al 1990 cast doubt on this as they have shown fusion of an os odontoideum to the base of the peg following posterior occipitocervical fusion. They concluded that excessive movement on the interposition of soft tissue may be more important that avascular necrosis (25). It is clear that both congenital and acquired mechanisms exist. Only when a definitely normal dens has been observed prior to a known injury can the presences of a separate dens be clearly identified as an acquired phenomenon. The occurrence of symptoms associated with an os odontoideum, congenital or acquired, is extremely variable, notwithstanding significant displacement of the structure in flexion and extension of the head and neck. Usually, the dens maintains its relationship to the body of the atlas, probably indicating integrity of the posterior transverse ligament. The acquired type of basilar invagination is trequenty found in diseases such as osteognesis imperfecta, osteomalacia, rickets, hyperparathyroidism, and Paget's disease.

Rheumatoid arthritis with its associated osseoligamentous destruction may decrease the effective sagittal diameter of the foramen magnum and is frequently associated with instability Atalanto-axial dislocation wasthe main cause of death in 8 % and contributory in 2 % of patents in a consecutive series of 104 autopsies of patients with rheumatoid arthritis (4,28).

The treatment of craniovertebral junction abnormalities can be divided into those patients whose spinal-cranial deformity can be realigned and reqire only stabilization, and those whose deformity cannot be realigned and thus require decompression (Fig 6).

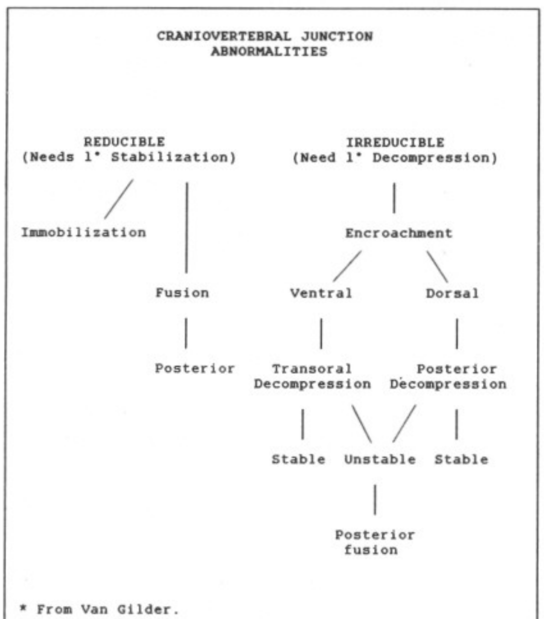

Fig 6 : Craniovertebral junction abnormalities

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