

Is sectioning of muscle attachment to axis (C2) spinous process mandatory to achieve arthrodesis during atlantoaxial fixation?

The basic and fundamental steps in atlantoaxial fixation technique that was discussed by us in 1994 include the opening of the atlantoaxial joint, denuding of the articular cartilage, and introduction of bone graft within the joint cavity, before plate/rod and monoaxial/polyaxial screw instrumentation.^[1-5] In addition, it was proposed that the muscles attached to the spinous process of axis (C2) should be sharply sectioned. Bone graft is additionally placed in midline over the arch of atlas and lamina of C2 to participate in and to provide added space for bone fusion. The host bone of lamina of C2 and arch of atlas are appropriately prepared by drilling and by denuding of all soft tissues. The combination of these steps appears essential for the success of the operation that is aimed at atlantoaxial arthrodesis.


Spinous process of C2 is strong, short and stubby. A number of short segmental and long multisegmental muscles are attached to the spinous process of C2 that provide pulls and pushes from a number of directions allowing a wide range of movements to the most mobile joint of the body, namely the atlantoaxial joint. On the other hand, there is no spinous process of atlas. All the muscles attached to the posterior arch of atlas are directed superiorly to the occipital squama in the shape of a fan, and function to stabilize the head on the neck. Essentially, all the movements at the atlantoaxial joint are regulated by the muscles attached to C2 spinous process [Figure 1]. The movements of the C2 are active, and the atlas provides a control ring for the movements. The strong and multidirectional muscles that are attached to the C2 spinous process act as wires of a pulley that work on the fulcrum point of the atlantoaxial facet



Figure 1: Cadaveric dissection showing extensive muscle insertion at the C2 spinous process

articulation and make atlantoaxial joint the most mobile joint of the body.

In our earlier article, we identified the role of the odontoid process in the atlantoaxial movements.^[6] We likened the movements at the atlantoaxial joint to a hand driven rickshaw, wherein the rickshaw puller holds the anterior ring of the rickshaw and the passengers are seated on the back seat. It was observed that it was not the strength of the rickshaw puller that allowed him to carry sometimes heavy passengers for several miles, but it was the biomechanical character of the make of the rickshaw wherein the two large wheels are the centers of the fulcrum that allows the rickshaw to function. The role of the rickshaw puller is to direct and control the rickshaw that is run over the large wheels. On similar lines, we identified that the role of the odontoid process is to control or direct the movements of the atlantoaxial region that occur at the facet joints. Odontoid process is the brain of

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movements, and the brawn of the activity is the large muscles attached to the C2 spinous process. We also observed that the intervertebral discs are similar to odontoid process in their role.^[7] They are like opera conductors that direct the movements without actually participating in the conduct of creating the music.

The distribution of the activity of the muscles of the spine can be observed by their bulk. In the spine, the posteriorly situated muscles are significantly larger than the anteriorly situated muscles. In the neck, the posteriorly situated muscles are thick and form the nape of the neck. On the other hand, the longus colli muscles located anterior to the spinal column are thin and essentially traverse from one vertebral body to the other without having any significant or strong attachment site. These muscles are essentially in the form of a veil or a curtain. The strength of the posteriorly located muscles makes the spine dominant in its extension movement which is its major active movement, while the flexion is a passive movement. The extension dominance appears essential for the standing human posture and for all major spine movements. In the atlantoaxial region, essentially, the axis moves while atlas bone remains still. All major movements at the most mobile joint of the body are orchestrated by the muscles attached to the spinous process of the C2. The movements are initiated and conducted by the muscles and are focused or centered at the atlantoaxial or lateral mass facetar articulation. The facets of the atlas and axis are round and flat, a design that permits circumferential and uninhibited movements. Such a flat articulation is not observed in any other actively moving joint of the body. While the shape and design of the bones of the facets of atlas and axis allow a wide range of movements, the character of its formation subjects it to the dangers of circumferential instability. It may not be incorrect to state that while atlantoaxial joint is the most mobile joint of the body; it is also the most unstable joint of the body. It appears that the atlantoaxial instability is an underdiagnosed and undertreated entity. Understanding of atlantoaxial instability can expand the scope of the surgeon to treating a host of spinal diseases that include degenerative spine issues, ossified posterior longitudinal ligament and Hirayama's disease.^[8-11]

Atlantoaxial instability can be best treated by procedures that attack the fulcrum point of spinal movements, namely the atlantoaxial joint. Wide denuding of the articular cartilage, stuffing of bone graft within the articular cavity and subsequent metal instrumentation form essential elements of the fixation process. Although stabilization and fixation may be possible by only instrumentation without

joint handling, the optimum environment of fixation is provided by directly blocking the movements. In the same tone, it is essential to block the very source of supply of the energy to the facets that is provided by the muscles attached to the spinous process of axis. As long as the muscles will remain active, they have the potential of destabilizing any kind of fixation implant. To provide maximal opportunity for arthrodesis, it is important not only to block the site or the fulcrum of movements, but also it is also important to block the energy engine of movements. To disable the pulley, it is essential to block the site of fulcrum and then disarm the strings.

Posterior approaches are biomechanically stronger and stable when compared to any anterior surgical approach to the atlantoaxial joint. Posterior approaches are superior as they are conducted in the direction of the activity of the movement and also have the possibility of detaching all the muscles attached to the spinous process of axis. In this context, it is important to mention that minimally invasive approaches for atlantoaxial fixation need to essentially incorporate the basic steps of fixation that include facetar joint disarticulation and detachment of the large muscle bulk attached to the spinous process of the axis.

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