Odontoid process and intervertebral disc: Do they have the same function?

We live in a world where great incompatibles co-exist: The human scale and the superhuman scale, stability and mobility, permanence and change, identity and anonymity, comprehensibility and universality.

– Kenzo Tange

The magnificent junction of the skull and the spine is not just an assembly of bones but is a unified flawless machinery of muscles, ligaments and bones that safeguard the nerves and vessels as they undergo their perilous journey at the craniovertebral intersection. The junction forms an epitome of immense mobility in perfect harmony with inherent stability engineered by the celestial “odontoid process.”

The Craniovertebral junction comprises of three bones—occipital bone, atlas and axis. Whilst occipitoatlantal joint is the most stable, atlantoaxial joint is the most mobile joint of the body. Craniovertebral junction is exquisitely crafted and designed by nature to provide safe transit pathway to the most critical neural and vascular structures whilst carrying lifelong the weight of the head and providing circumferential movements to the neck. A strong muscle group powers the movements, and ligaments anchor the foundation of joints. In relative terms, the transverse process of atlas and spinous process of axis are the largest and the facets of atlas and axis strongest when compared to rest of the spine. Through their muscle attachments, transverse process of atlas caters to rotatory neck movements and the spinous process of axis caters to neck flexion and extension movements. The well-built and brawny facets of atlas and axis and the grand atlantoaxial articulation guided by the directives of the odontoid process provide fulcrum and a focused point of movements to the muscle pulleys.

Mobility is dynamic whereas stability without mobility leads to stagnation.

Despite the fact that the craniovertebral junction is the hallmark of stability and mobility, absence of the intervertebral disc: “the movement generator and designer” in the scheme of things makes you ponder and raises critical questions.

Intervertebral discs laid one above the other are indeed a marvel of engineering design. Each disc (also called pulvinot or cushion/pillow) is a sphere of strong fibrous tissue (annulus or spherus fibrosus), containing in its center a ball of mucoid connective tissue called nucleus pulposus. The two comprise a ball-within-ball joint that works on the same principle as does a pneumatic tire. The compression exerted on the nucleus pulposus makes it stretch the spherus fibrosus, the compression/stretch forces absorbing the weight impact and thus allowing a porter to carry a huge load on the head. As mentioned in our earlier article on the subject, the nucleus pulposus belongs to the category of mucoid connective tissue that is located at the root of each tooth, thus allowing a human or a hyena to exert a pressure as high as 500 pounds per square inch, without hurting the jaws.

“Nature has put a series of fluids (synovial fluid, cerebrospinal fluid, blood, and nucleus pulposus) as shock acceptors that render the human frame essentially weightless. For comparison, one can see that the strongest part of the 70,000-kg jumbo-jet are its nitrogen-filled tires whose combination of compression of the gas and stretch of the tire-fibers makes this monster of a machine essentially weightless as and when it lands on the tarmac to give us a cushioned landing, greatly aided by the 12–14 feet column of oil in its landing gears.”

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of a car or of an airplane, the disc provides for shape, strength, and movement of the spine, while assisting in making the body essentially weightless.

Our analysis suggests that the disc and the odontoid process have remarkably similar analogy. From its strategic location, it is apparent that the odontoid process has replaced the disc and taken over its task in the craniovertebral junction. The muscle pulleys active in the craniovertebral junction and the rest of the spine have their bulk in the posterior and lateral aspect. Muscles in the proximity to the disc and to the odontoid process in the anterior aspect of the spinal column are thin and veil-like and their role in executing or assisting movements is unclear. Essentially, all the major muscles act with their focus on the facets and are away from the disc and the odontoid process.

In the year 2015, we hypothesized that the odontoid process and the intervertebral discs are like opera conductors that regulate all movements without playing or directly handling any instrument. We likened the odontoid process to a hand pulled rickshaw driver. It is not the strength or power of the rickshaw puller that is the driving force, but the design of rickshaw with big wheels and long handle that allow the rickshaw puller to run the rickshaw even when it is very heavily loaded. The running of the rickshaw and the direction of its travel are dependent on the dictates of the rickshaw puller. Essentially, the brain of the movement is the rickshaw puller; the design of the wheels powers the movements. On similar lines, it seems that the discs are the brain of spinal movements, the brawn being the muscles that act on the facets.

The remarkable ingenuity of nature in the event of manifest or potential atlantoaxial instability are well known. The attempts of nature to avoid or minimize the potential effects of atlantoaxial instability and compression of critical neural structures have been described earlier. Musculoskeletal alterations include short neck, short head, torticollis, Klippel-Feil abnormality, bone fusions, and platybasia. Neural alterations include Chiari formation and syringomyelia. Syringomyelia seems to be “self-neural-destruction” in an attempt to buffer the potential consequences of atlantoaxial instability. In the event of chronic atlantoaxial instability, it appears that os-odontoidum is a result of nature’s self-fracture of odontoid tip. Both os-odontoidum and bifid arch of atlas seem to be nature’s attempts to avoid inadvertent squishing of the cord, which would have occurred in the presence of the normally formed bony framework. Self-reduction in the size of disc in the event of vertical spinal instability related to spinal degeneration is known. Our impression is that both disc and odontoid process are directly under divine and unfathomable control.

The ingenuity of the mechanism of both the disc and the odontoid process is indeed exquisite. Both intervertebral disc and odontoid process appear like directors of spinal movements and play a role of protectors by being the first line of defense when the situation so demands.

The profoundly subtle protective processes, however, make me feel that there has to be – there must be – another force – a certain spiritual force, and some divine conductor – that coheres it altogether into a very fine orchestra creating a mesmerizing symphony that gives one – certainly it gives me – a profound sense of certain sacred awe.

At moments like this, I feel deeply humble, as well as deeply exalted.

The great Albert Einstein once observed that “Nature shows us only the tail of the lion. But there is no doubt in my mind that the lion belongs with it even if he cannot reveal himself to the eye all at once because of his huge dimension.”

I wonder why do we see only the tail?

Is the lion really there?

How can we see it?

Can it be seen?

“Nature hides her secret”, Einstein observed again, “because of her essential loftiness, but not by means of ruse.”

Nature is indeed lofty

Very lofty

We have to balance the lineality of the known universe with the nonlineality of the unknown universe

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REFERENCES

1. Kothari M, Goel A. The so-called intervertebral disc: A 4-D reverie. Neurol India 2007;55:97-8.
2. Goel A. Treatment of odontoid fractures. Neurol India 2015;63:7-8.