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Editorial

# Artificial atlantoaxial joint: Is it a possible option?

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For decades, the focus of surgical attention for craniovertebral junction instability is stabilization of the unstable atlantoaxial joint.[1,2] The stabilization of the joint aims at arthrodesis. The net result is loss of function of one of the most mobile joints of the body. Although other cervical spinal segments then participate and affect the lost function, there remains a certain degree of movement restriction. Attempts to restore the degree of movements of the neck without compromising the stability of the joint are the future goals of the surgeon dealing with craniovertebral junction.

We report "artificial" atlantoaxial joint prosthesis and propose the mechanism of its insertion and function. Although it is premature to state that the artificial atlantoaxial joint will be as effective in its function as an artificial knee or hip joint, the proposed joint model can be a harbinger of further innovations and developments for better designs and material that can provide wider and smoother movements for a longer period of lifetime. The complexity of the surgery, wide range of movements in the region, and devastating effects of possible failures make use of artificial atlantoaxial joint a less attractive option.

Our design for artificial atlantoaxial joint incorporates two plates and a ball and socket construction, as shown in the [Figures 1-3]. Each plate has a socket for screws that fixate it to the facet of atlas and facet of axis. The ball rests on the cup, free to move circumferentially, and restricted only by the ligaments.

The proposed artificial prosthesis for atlantoaxial joint is rather simple and solid in its structure and design. The weight of the head and the inherent elasticity of the ligaments keep the ball opposed to the cup. For the construct to be functional, the two artificial joints on two sides have to work in harmony and in unison. It is also necessary that the movements are limited to the normal human range and does not become excessive. The ball and socket joint model represents articulations with three rotational degrees of freedom. It allows an axial motion (twist) of the segment, that is, one degree of freedom and a spherical motion (swing) that determines its direction, that is, two degrees of freedom. The ball and socket joint allows rotation and back and forth motion in all planes.

Atlantoaxial joint has a range of movements. The primary movement occurring at the C1-C2 joint is axial plane rotation.

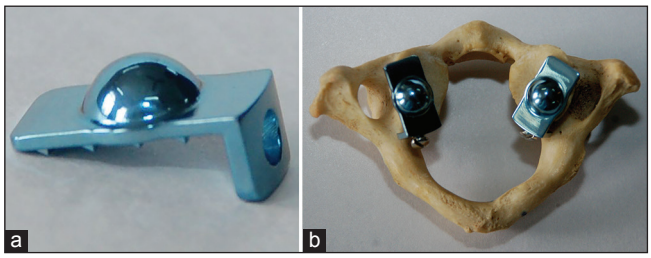


**Figure 1: (a) Implant for the atlas facet. It shows the ball of the ball-socket joint. Note the serrations on the facet surface of the implant. The angle projection has a hole that would accommodate the screw that will be implanted in the facet of the atlas. (b) Undersurface of the atlas bone showing the positioning and stabilization of the implant**

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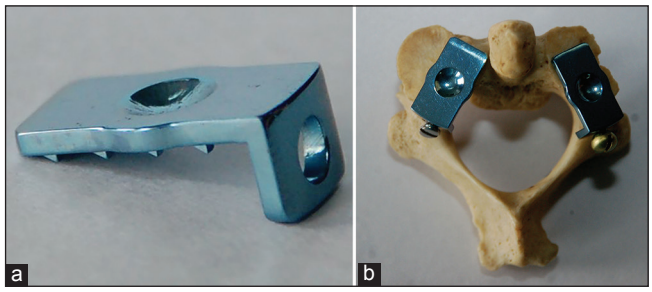

**Figure 2: (a) The implant for the axis facet. Its rostral surface has a socket that will align with the ball of the atlas implant. The facet surface has serrations for stabilization. The angle has a hole for screw insertion into the axis facet. (b) Implant in the position on the lateral mass of axis vertebra**

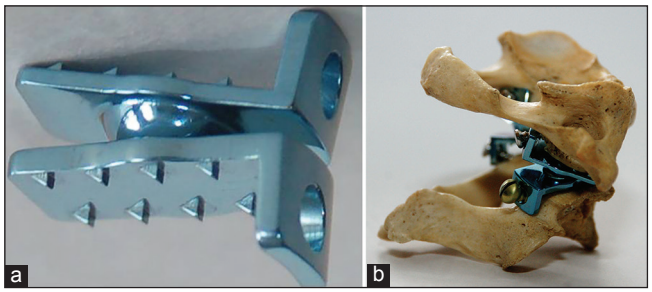

**Figure 3: (a) The implants in position. (b) The implants placed in a dry cadaveric bone**

On an average, 23-39° of rotation per side is allowed.[3] The C1-C2 articulation, ipsilateral transverse ligament, contralateral alar ligaments, and the capsular ligaments limit the degree of movements. Axial rotation at C1-C2 is associated with up to 11° of lateral bending in the opposite direction. Lateral bending at the C1-C2 other than that associated with axial rotation is limited to 6.8° primarily by the alar ligaments. Sagittal plane rotation is limited to 10.1-22.4° by the transverse ligament in flexion, the tectorial membrane, and the bony anatomy of the C1-C2 articulation.[3] It is unclear if all the naturally occurring movements can be duplicated by the discussed prosthesis. However, a certain range of movements can certainly be possible. Attempts have been made earlier to introduce artificial atlanto-odontoid joint by the transoral route.[4,5] The prosthesis is positioned after anterior decompression of the region. The authors identify that the implant assists in restoring C1-2 axial rotation that is lost following stabilization procedures.

It appears that the proposed artificial atlantoaxial joint will not only assist in facilitating the complex movements that occur at the joint, but can also assist in relieving the symptom of pain that is a result of degenerative arthritis involving the craniovertebral junction. In our earlier study, we analyzed the rather frequent occurrence of degeneration at the craniovertebral junction.[6]

The purpose of introduction of an artificial atlantoaxial joint is to attempt to retain the movements of the joint while introducing a factor of stability. The primary issue is that the stability should not be compromised while the movements of the joint are maintained. The movements should be smooth and jerk-free. The need of introduction of fluid between the joint surfaces has to be assessed and deployed. The material used was of medical grade titanium. However, better material that will be superior in its other material properties such as softer metals and plastics are also possible.

The biomechanical strength of the artificial joint will need to be assessed on the basis of specialized study. Despite our enthusiasm, we are still hesitant to use the implant in actual clinical practice. Further experimental evaluation and trials will be mandatory before any clinical use is possible. It is also necessary to evaluate the long-term effectiveness and functionality of such an artificial joint.

## DISCLOSURES

The implants are the proprietary item of GESCO-India. The patent on the product has been applied and is pending. The implant has not yet been in clinical use. Biomechanical studies are underway.

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