Artificial atlantoaxial joint


The authors are correct in stating that the atlantoaxial joint is a highly mobile joint, and while the preservation of stability is paramount, attempts must be made toward retaining the movements of the region. Thus, any implant or device that provides both stability and mobility to the region is most appropriate.

The craniovertebral junction is a structural masterpiece of nature designed to be the most stable and the most mobile region of the body and architected to provide an uncompromising and safe passage to the most critical neural and vascular structures. The atlantoaxial joint is the most mobile joint of the body and is active in saying both “yes” and “no” by virtue of its circumferential movements and moves tirelessly and flawlessly throughout its life. Our long-term experience in the field indicates that complexities of the region are so huge, the natural design so intricate and flawless, that any human effort to mimic the atlantoaxial joint can only be an unrealistic dream.

Shen et al. have conducted a biomechanical analysis on cadavers and have identified instrumentation that provides both stability and mobility to the atlantoaxial joint. The usefulness of such a device will have to be identified on the basis of subsequent studies. The more critical issues in the conduct of the surgery and its success are that the procedure should be technically simple and the implant needs to be physically sturdy and long-lasting. The movements permitted by the device should be optimum and not more than the normal range. The devastating effects of failed treatment should also be realized.

As the authors have mentioned, efforts to restore stability and retain mobility are rarely discussed. In this context, I invite the authors to view our description of an artificial atlantoaxial joint, which I believe to be the first described in the literature. We designed an artificial joint in the form of a ball-and-socket construct (Fig. 1). We believe that our design of the artificial joint is rather simple and possibly effective. Biomechanical analysis of the feasibility of the proposed artificial atlantoaxial joint is in progress. However, our current impression is that our construct and that described by the authors are only experimental and far from being ready for any clinical use. It is premature to state that the artificial atlantoaxial joint can ever be as as effective in its function as an artificial knee or hip joint. However, it is also true that such efforts can only serve as motivation for further innovations and developments.

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FIG. 1. A: The ball-and-socket articulation is visible. The serrated surface of the implant will be in proximity to the surface of the bone of the facet. B: The fixed implant on the undersurface of the facet of the atlas. The ball on the implant will articulate with the socket in the implant on the axis bone. C: The implant fixed to the facet of the axis bone. The socket is meant for the ball-and-socket articulation. D: The fixed implant and the articulation. Reprinted from Goel A: J Craniovertebr Junction Spine 6:147–148, 2015. CC BY-NC-SA 4.0. (https://creativecommons.org/licenses/by-nc-sa/4.0/). Figure is available in color online only.
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Disclosures
The author reports no conflict of interest.

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Response
We sincerely thank Dr. Goel for his keen interest and profound insights into artificial atlantoaxial joints, as well as his advice.

Our novel posterior artificial atlanto-odontoid joint (NPAAJ) is designed to stabilize the C1–2 complex and achieve motion in different planes, and the surgery used to implant our device is based on the technology used for pedicle screw implantation. Because the NPAAJ requires normal lateral C1–2 joints to achieve motor function, we believe that it is unsuitable for lateral C1–2 joint disorders. Therefore, the NPAAJ may be useful for treating atlantoaxial instability (AAI) disorders caused by congenital odontoid dysplasia, odontoid fracture nonunion, and C-1 transverse ligament disruption (IA, IB, and IIB). The artificial atlantoaxial joint Dr. Goel designed is very unique and may be used in patients with AAI not only due to ligament injuries and fractures but also caused by lateral C1–2 joint diseases such as rheumatoid arthritis and tumors.

The atlantoaxial complex is a very complex structure, and the relative trajectories of C1–2 are also complex and irregular, especially the trajectory of the lateral joint. Currently, there are few studies on the trajectory of the lateral C1–2 joints. Therefore, we intend to further study the trajectory of C1–2 to improve the design of the NPAAJ. Dr. Goel’s artificial joint is in the form of a ball-and-socket construct, which is a very good idea. However, we think that the concave design of the joint surface is not suitable for a sphere. We suggest that appropriate improvements would be based on the trajectory of the lateral C1–2 joints to achieve better C1–2 lateral bending and axial rotation. In addition, we propose that osteotomy of the upper and lower articular surfaces of the lateral C1–2 joints should be performed to facilitate the placement of his prosthesis and reduce the tension of peripheral blood vessels, nerves, and ligaments.

The design of his artificial joint is very good, and we believe that he will obtain very good results through his continuous improvements and research. Our study is a preliminary study of cadavers, and our device has not yet been implanted in patients. In future studies, including live animal experiments, we intend to increase the range of motion of C1–2 with respect to flexion, extension, and rotation and improve the articular surfaces of the NPAAJ.

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