INTRODUCTION:
The involvement of the cervical spine occurs in 25% to 80% of patients with rheumatoid arthritis (RA) [1]. Surgical treatment is considered useful in preventing further progression of the cervical deformities that can lead to myelopathy and sudden death [2]. Three types of deformities occur commonly in the case of cervical spine involvement in RA, namely, atlantoaxial subluxation (AAS), vertical subluxation (VS), and subaxial subluxation (SS). Although dynamic analysis of the cervical spine in RA patients is important, the exact measurement of the cervical spine motion in vivo has not yet been established. The purposes of the current study were to perform an in vivo measurement of segmental cervical spine motion in RA patients and to reveal the instability pattern accompanying AAS in the cervical flexion and extension positions; these were accomplished using a patient-based three-dimensional (3D) magnetic resonance imaging (MRI) computer model.

METHODS:
Ten RA patients (9 females, 1 male; age 36–72 yrs; mean age, 62 yrs), who were diagnosed with AAS by plain radiography, underwent MRI of the cervical spine in the neutral, flexion, and extension positions. The study was approved by the institutional ethics committee. T2-weighted sagittal MR images of the cervical spine in the neutral, flexion, and extension positions were obtained by using established protocols. 3D computer models for each vertebral body were reconstructed from the MR images in order to perform the virtual merge method (Fig.1). In this method, a custom-made software program was used as previously described [3] to virtually rotate the image of a vertebral body acquired in the neutral cervical position and translate it toward its own image captured in the cervical flexion or extension position; this process was continued until the highest value of volume merge was obtained. These rotations and translations of the vertebral body were conducted with 0.05 degree and 0.05 mm increments, respectively. Differences in the intervertebral levels were compared by analysis of variance (ANOVA) and the Fisher’s post hoc test. Statistical significance was evaluated at the α = 0.05 level.

RESULTS:
The segmental motions were divided into rotational and translational motions. Three rotational axes, namely, flexion/extension (FE), lateral bending (LB), and axial rotation (AR), were examined; the motion of FE was used as the rotational segmental motion because the coupled motion of LB and AR was almost negligible (mean, 0.0; range, 0–0.2). The magnitude of the translational segmental motion was calculated in three directions (anterior-posterior, top-bottom, and left-right); overall evaluation of the motion was done using the sum of squares of these motions. There were no significant differences in the rotational segmental motion in flexion (Fig.2). C1-C2 had a greater rotational segmental motion than that observed at all other spinal levels in extension (Fig.2, p < 0.03). The values observed for the translational segmental motion for C1-C2 and C2-C3 were greater than those ascertained for the lower vertebral levels (C4-C5 to C6-C7) in both flexion and extension (Fig.3, p < 0.05).

DISCUSSION:
This study demonstrated that the noninvasive techniques employed using the 3D MRI computer model and the volume merge method accurately measured the 3D segmental motion of the cervical spine in RA patients in vivo. Some reports have demonstrated instability patterns of the cervical spine in RA using two-dimensional methods such as radiography and cineradiography [4]. Recently, in vivo 3D measurements using MRI and computer tomography (CT) have been used for the analysis of the segmental motion of the spine [3, 5, 6]. In this study, the atlantoaxial joints in the RA patients with accompanying AAS had greater rotational motion in extension. This study also showed that the segmental motion of the upper cervical spine is greater than that of the lower cervical spine in flexion and extension. The atlantoaxial joints, which play important roles in the rotation, flexion, and extension of the head and neck, are deformed and destroyed by synovitis and the formation of inflammatory pannus; this may lead to instability and subluxation of the joints [1, 2]. This study demonstrated that the coupled motion associated with flexion and extension was minimal in the RA patients involved in the study. However, an asymmetrical destruction of the vertical spinal segments may occur in the progressed stage of RA and cause complex coupling segmental motions during various cervical motions [4, 7]. The method used in this study allows measurement of 3D segmental motions, which will be useful to evaluate the coupled motions in such cases. This study provided the cervical segmental motion during flexion and extension in the RA patient, but a deviation from the normal pattern can not be evaluated since no data are available in the normal subjects. Future study will include the normal subjects to identify an abnormal pattern of the segmental movements in the RA patients.

REFERENCE:

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