Real time kinemtaic imaging of the ocular movement using FIESTA with tagging method

T. Masui[1], M. Katayama[1], K. Sato[1], M. Sugiyama[1], H. Seo[1], A. Kutsuna[1], M. Hirano[2], A. Nozaki[2], and H. Sakahara[3]

[1]Radiology, Seirei Hamamatsu General Hosiptal, Hamamatsu, Shizuoka, Japan, [2]GEYMS, Hino, Tokyo, Japan, [3]Radiology, Hamamatsu University School of Medicine, Hamamatsu, Shizuoka, Japan

Introduction After orbital fracture or surgical repair of the fractured orbit, diplopia is one of the major problems due to the adhesion of the extraocular muscle to the surrounded soft tissue or fractured bony structures. Magnetic resonance (MR) imaging is a suitable modality for the evaluation of the soft tissue in the orbit without radiation effects and kinematic MR is useful to assess the ocular movement. After surgical treatment for the adhesive extraocular muscle, the ocular movement may gradually recover over months or years. Thus, repeated studies are required for monitoring. To assess the degree and features of the ocular movement, qualitative and semi-quantitative evaluation is desired. Accordingly, the purpose of this study was to evaluate the usefulness of the real time kinematic MR imaging for the ocular movement with fast imaging employing steady-state precession (FIESTA) in combined use of tagging method.

Materials and Methods *Subjects*: Forty subjects underwent kinematic MR imaging for the evaluation of the ocular movement. Among them, 30 subjects (20 men, 10 women, mean age 33 years old) were included, who had suspected the vertical ocular movement. *MR imaging*: All the subjects were studied with a 1.5T superconducting magnet (HD Twinspeed, GE medical system) using an 8 channel head coil. Oblique-sagittal images parallel to the optic nerve were obtained according to the symptoms, past-history of the trauma, or medical records for the surgery. In the gantry, the 10 steps of marks were drawn in front of the subjects for the adjustment of the degrees of the vertical ocular movement. The subjects sequentially followed each line in order upward or downward while MR imaging with FIESTA was repeated in combined use of parallel imaging (array spatial sensitivity encoding technique; ASSET). At the first phase of imaging, tagging RF pulse was applied to generate horizontal lines. The imaging parameters were as follows; FIESTA TR 4 msec, TE 1.6ms, FA 90 degrees, section thickness 5mm, matrix 192x192, FOV 22x22cm, acquisition time 1 phase 0.5sec. Oblique-sagittal static T1-weighted FSE imaging was also obtained as reference with the following parameters; TR 500msec, TE 9ms, FA 90 degree, section thickness 5mm, matrix 256x160, FOV 16x12cm. *Evaluations*: Image quality, susceptibility artifact, existence of the adhesions were evaluated with the kinematic display of each imaging as well as with the static single slice image using a 5 point-scale. 1 stands for the worst image quality, or definitely existence of adhesion and 5 stands for the excellent image quality, or definitely no-adhesion. All the evaluation was made on the display monitor (Centricity, GE). For the evaluation of dysfunction of the ocular movement, the point of lower than 5, and higher than or equal to 5 was regarded as for the existence and absence of the dysfunction, respectively. In objective evaluation, the angle of the tagging line and horizontal line was measured on each phase of the image. The angle was plotted against the each phase.

Results The score of susceptibility artifacts was 8.1 on the left and 8.5 on the right. Over all quality was ranked as 8.4. Image quality for SE images was 9.2. The detection of the dysfunction of the ocular movement on kinematic images was made with sensitivity, specificity, and accuracy of 0.84, 1.0, 0.86, respectively. On FSE images, that was made with 0.76, 0.5, 0.72, respectively. The degree of the ocular movement was demonstrated on right and left eyes in real time (Fig1a,b) and the time-angle curve was generated for each eye (Fig 2). The pattern of curves gave information of the degree of the maximum ocular movement as well as features of the ocular movements.

Summary Kinematic information of the orbit is essential for the evaluation of the ocular movement with adhesion. Repeated evaluation of the ocular movement may be desired with the characterization of the ocular movements since after repair of the adhesive extraocular muscle, gradual recovery will occur over months or years. In the current study, real time imaging of the eye was performed using fast imaging of FIESTA with ASSET, and either upward or downward total imaging time was approximately 5 seconds and tagging lines gave clues for assessment of degrees of the ocular movement.

Conclusion Tagging FIESTA images provide useful kinematic information of the ocular movement in a real time fashion. A time-angle curve provides features of the ocular movement and might be useful for the estimation of the recovery of the ocular movement semi-quantitatively.

Fig1a

Fig1b

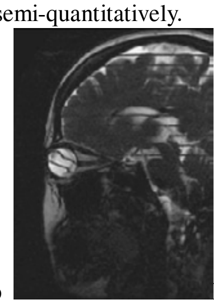

Fig2