Percutaneous screw fixation for traumatic spondylolisthesis of the axis using three dimensional fluoroscopy-assisted navigation

(Introduction) Stable hangman’s fractures are usually treated with a Halo vest fixation; however, this is not always effective in patients with polytrauma. These patients benefit from minimally invasive surgery because it allows for early rehabilitation and reduced nursing care. This is the first report on percutaneous screw fixation using three dimensional fluoroscopy-assisted navigation in patients with polytrauma and hangman's fractures.

(Methods) We report the six cases of hangman fractures with polytrauma treated by posterior percutaneous direct screw fixation using Iso-C computer navigation. All of the cases were classified as Levine and Edwards type 2 injuries. For image acquisition the patients were placed on a radiolucent carbon bed with their head in a carbon Mayfield head-holder to minimize imaging artifact. A dynamic reference arc was attached to the spinous process of the axis through a small incision. The Siremobil Iso-C3D (Siemens Medical Solutions USA, Inc) then acquired multiple successive images as it performed an automated 190 degrees rotation around the patient. After image acquisition, the fluoroscope workstation generated 3 dimensional reconstructions of the imaged anatomy. We made two small, lateral incisions for percutaneous screw insertion, and used an image-guided awl to create screw trajectory. Guide wire was inserted through this screw trajectory, and a cannulated cancellous screw was inserted over the guide wire.

(Results) The average surgical procedures lasted 78 min, with 80ml of blood loss. The patients had no neuro-vascular complications during the surgeries. At the final follow-up, cervical alignments were normal and bony unions were achieved in all of the cases.

(Discussion) Surgical procedures for hangman fractures include reports of posterior C2-3 fusion, anterior fusion with a plate and osteosynthesis using direct screws. Osteosynthesis using screws
has the benefit of maintaining normal cervical ROM. In this study, the patients had poly-trauma making it difficult to fit an external cervical fixation such as the halo-vest. Minimally invasive surgery and osteosynthesis using direct screws were extremely beneficial for the patients allowing them to achieve early rehabilitation and reducing nursing care. Our study demonstrates three advantages of minimally invasive surgery for hangman fractures using 3D fluoroscopy-assisted navigation. First, anatomical registration is not required. As a result, 3D fluoroscopy allows for percutaneous screw placement. We made a small incision to attach the reference arc to the spinous process of the axis. Second, the images used for navigation are obtained with the patients already in the desired position for surgery, and post-reduction cervical alignment can be assessed. Finally, 3D fluoroscopy can be used to generate an intraoperative, post-procedural CT images to verify the accuracy of the screw placement.

(Conclusions) This procedure avoids registration errors and improves accuracy and safety. Intraoperative 3D images by Iso-C can obviate the need for postoperative imaging and intraoperative acquisition of 3 dimensional images avoids registration-related problems. It will be applicable to minimum invasive surgeries.