Damage to MR Scanners Caused by the Tsunami that Followed the Great East Japan Earthquake in 2011

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The Great East Japan Earthquake (GEJE, magnitude: 9.0), the largest one in modern Japanese record, struck east Japan at 14:16 (JST) on March 11, 2011. The Great Hanshin Awaji Earthquake (GHAE) in 1995 (magnitude: 7.3) was the first great earthquake after MR scanners became commonplace in medical facilities. Since GHAE, anchoring of radiological facilities has been emphasized to prevent earthquake damage. In GEJE, we encountered a tsunami disaster, which has not been a major concern in MR safety management. Among the 187 facilities with MR scanners in Iwate and Miyagi Prefectures, 43 facilities within 10 km of the Pacific coast were selected for this investigation.1,2 Basic information on the disaster, such as the flooded area and magnitude distribution, was obtained using public databases.2-5 The details of flooding and damage to each facility were confirmed by questionnaires and interviews at each facility based on a research protocol approved by the institutional review board. For the classification of tsunami hazards in relation to MR scanners, items such as damage to the buildings, in/out-flow of debris and the quench status of the superconducting magnets (SCM) were investigated.

In GEJE, damage to MR scanners due to the tsunami was reported in 12 facilities, and MR scanners survived although the facilities were partially flooded in the other 7 facilities.1 These 19 facilities were located within 3 km from the Pacific coast, and their altitude was approximately less than 12 m above sea level (Fig. 1 A). On the other hand, it was noted that public hospitals relocated onto hills over 20 m above sea level showed no flooding of MR scanners (Fig. 1 B).

The damage to MR scanners was classified into three types, as shown by the colors in Fig. 1: Destructive type: The entire facility is directly struck by the tsunami, and totally destroyed, sometimes washed away. Subsystems of the MR scanner or even magnets may be lost. High-pressure type: The flood may destroy the doors or windows of the scanner room and the entire MR scanner room is filled with large debris including metal materials. Low-pressure type: The inflow is relatively slow, with some floating objects around the scanner room and mud from the sea. The MR scanners or scanner rooms are free from major structural damage. In three of the 5 flooded SCM cases, which were clas-
The relationship between flood damage to MR scanners and their geographical characteristics is summarized. Horizontal line: height above sea level (m), Vertical line: distance from the Pacific coast (km). The MR scanners installed to clinics close to the coast (A) were flooded, while those in hospitals located or relocated on hills (B) survived. Damage to MR scanners due to the tsunami was confirmed in 12 facilities, and classified as the destructive type (red triangle), High-pressure type (green triangle), and Low-pressure type (blue triangle). In 7 facilities (black circle), MR scanners were not damaged, although the facilities were partially flooded. The other 24 facilities were not flooded (open circle). The damage type depends not only on the distance from the coast and height above sea level, but also on the complex geographical conditions of the local areas, such as the shape of the bay, slopes around the facilities, small mountains between the coast and the facility, and floor planning of buildings.